Technical Report Documentation Page

1. REPORT No.
FHWA-CA-TL-7080-77-25

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Air Pollution And Roadway Location, Design And Operation
Project Overview

5. REPORT DATE
September 1977

6. PERFORMING ORGANIZATION

7. AUTHOR(S)
G.R. Bemis, A.J. Ranzieri, P.E. Benson, R.R. Peter, K.O. Pinkerman, and B.T. Squires

8. PERFORMING ORGANIZATION REPORT No.
19701-657080

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Office of Transportation Laboratory
California Department of Transportation
Sacramento, California 95819

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

12. SPONSORING AGENCY NAME AND ADDRESS
California Department of Transportation
Sacramento, California 95807

13. TYPE OF REPORT & PERIOD COVERED
Final July 1971 to July 1977

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
The research reported herein was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration under the research project titled "Air Pollution and Roadway Location, Design and Operation".

16. ABSTRACT
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17. KEYWORDS
Microscale air quality modeling, mobile air quality research laboratories, primary pollutants, secondary pollutants, meteorological data, traffic, air quality data base

18. No. OF PAGES:
200

19. DRI WEBSITE LINK
http://www.dot.ca.gov/hq/research/researchreports/1976-1977/77-25.pdf

20. FILE NAME
77-25.pdf

This page was created to provide searchable keywords and abstract text for older scanned research reports.
November 2005, Division of Research and Innovation

DIVISION OF STRUCTURES AND ENGINEERING SERVICES

TRANSPORTATION LABORATORY

RESEARCH REPORT

AIR POLLUTION AND ROADWAY LOCATION, DESIGN, AND OPERATION PROJECT OVERVIEW

FINAL REPORT

FHWA-CA-TL-7080-77-25

SEPT. 1977

Prepared in Cooperation with the U.S. Department of Transportation, Federal Highway Administration

Caltrans

CALIFORNIA DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

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19. SECURITY CLASSIF. (OF THIS REPORT) Unclassified	20. SECURITY CLASSIF. (OF THIS PAGE) Unclassified	21. NO. OF PAGES 200	22. PRICE

DS-TL-1242 (Rev.6/76)

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF STRUCTURES & ENGINEERING SERVICES
OFFICE OF TRANSPORTATION LABORATORY

September 1977

TL No. 657080

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this final research project report titled:

AIR POLLUTION AND ROADWAY LOCATION,
DESIGN AND OPERATION
PROJECT OVERVIEW

Study made by	Enviro-Chemical Branch
Under the Supervision of	Earl C. Shirley
Principal Investigator	Carl R. Sundquist and Andrew J. Ranzieri
Co-Principal Investigators	Kenneth O. Pinkerman and Gerald R. Bemis
Report Prepared by	Gerald R. Bemis Richard Peter Paul Benson Kenneth O. Pinkerman Bennett T. Squires

Very truly yours,

George A. Hill

GEORGE A. HILL
Chief, Office of Transportation Laboratory

PB:bjs
Attachment

ACKNOWLEDGEMENTS

This report has been authored by Andrew J. Ranzieri, Gerald R. Bemis, and others under the supervision of Earl C. Shirley, Chief, Enviro-Chemical Branch.

Funding for this research project was provided by the Office of Research, Federal Highway Administration. Dr. Howard Jongedyk, and, more recently, Mr. Ken Jones have both been project managers for the FHWA.

Acknowledgment is gratefully given to Kenneth O. Pinkerman, Robert W. Breazile, and Orvis Box who developed, constructed, and field tested the mobile research laboratories. They were supported by the expert work of the Transportation Laboratory's Machine and Electrical Shops. Special acknowledgment is given to Richard Peter who performed extensive work in system performance evaluation and to the Air and Industrial Hygiene Laboratory of the California Department of Health who provided continuous support in the areas of instrument calibration and quality control.

Acknowledgement is also given to the personnel in District 07 who operated the research laboraties and collected the data. These include Jean Smart, field supervisor, Clark (Gip) Gipson, Rudy Abangan, Jim Ito, and Arnold Mahalona. Without the team effort of these people, this project would not have been possible.

The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and the accuracy of the information presented herein. The contents of this report do not necessarily reflect the official views of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Neither the United States Government nor the State of California endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this document.

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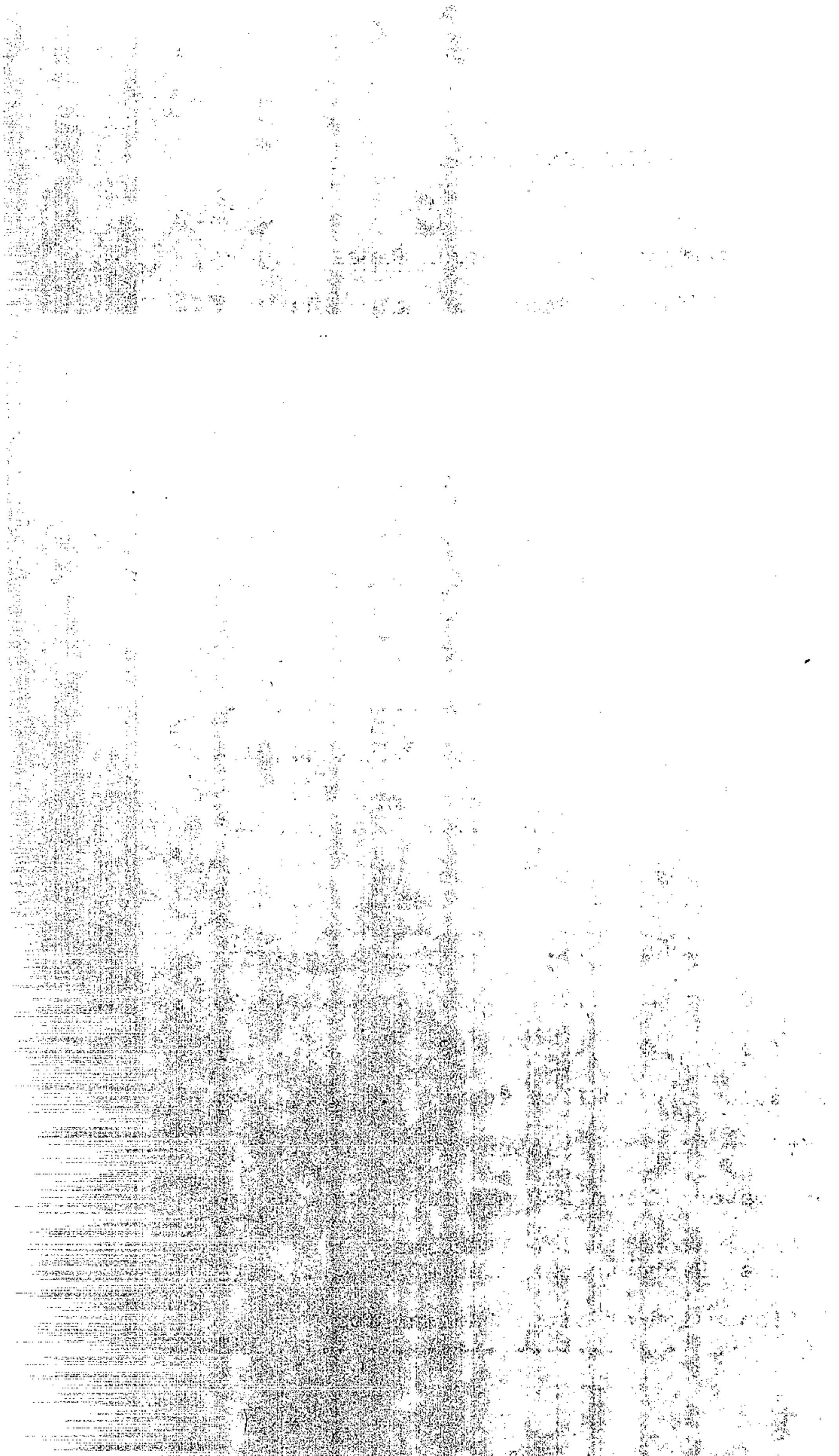


LIST OF FIGURES (Continued)

FOREWORD

This report describes a large-scale air monitoring and model verification program undertaken by the California Department of Transportation (Caltrans) in cooperation with the Federal Highway Administration (FHWA). This work was largely funded by FHWA.

The results of the program were many and varied. Valuable knowledge was gained regarding the sensitivity of air quality monitoring devices to operating conditions and sampling techniques. An extensive data base was set up to help in the development and validation of future line source models. Two versatile and sophisticated mobile research laboratories were constructed and thoroughly tested.

The objectives of the program, the nature of the field data collected and a broad overview of the project are contained in this final report.

INTRODUCTION

Air pollution occurs in many different forms and results from many different sources. The forms of air pollution vary from noxious and highly toxic gases to minute pieces of solid and liquid material. The sources range from dust storms and volcanic eruptions to fires in backyard incinerators.

The primary pollutants from the spark ignition internal combustion engine are: Carbon monoxide (CO), oxides of nitrogen (NO_x), hydrocarbons (HC), lead, and particulates. Two of the primary gaseous pollutants, oxides of nitrogen and hydrocarbons, react in the presence of ultraviolet light to form secondary pollutants. The principal secondary pollutants which have been identified are ozone (O_3), peroxyacetyl nitrate (PAN), and peroxybenzoyl nitrate (PBN). All of these compounds are very active oxidants and have an extensive effect on health and vegetation. California, with its cities built on flat lands surrounded by mountain ranges, a persistent inversion aloft, a tremendous amount of ultraviolet radiation, and a high concentration of automobiles in its principal urban areas, is an ideal breeding ground for photochemical smog.

The principal factors affecting pollutant concentrations are: the downwind distance between the receptor and the source, the wind speed and associated turbulence, the source strength, the mixing depth and solar radiation. In general, for primary pollutants, the greater the distance between source and receptor, the more chance there is for dispersion to occur and hence lessen the concentration. Higher wind speeds have the effect of increasing the amounts of air into which the emitted pollutants are dispersed, thus causing greater dilution. Vertical turbulence further promotes the dispersion of pollutants. The mixing depth dictates the volume of clean air available to dilute the pollutants.

People living, working, or attending school immediately adjacent to a line soure such as a highway are affected when localized pollutant concentrations reach levels injurious to their health. This is the microscale effect and it must be analyzed and quantified in terms of pollutant concentration. The environmental impact statement process requires, among other things, that reliable microscale estimates be made for proposed projects. The indirect source review process, when implemented, also requires these microscale pollutant estimates.

In order to estimate microscale pollutant levels with a degree of reliability, the California Department of Transportation (Caltrans), funded by the Federal Highway Administration and the State of California, initiated a study with the following objectives:

1. Determine the temporal and spatial distributions of highway-generated air pollutants adjacent to major freeways in the Los Angeles area for various types of highway design (at-grade, elevated, and depressed freeway cross sections).

2. Develop and evaluate prediction models which can estimate chemically inert pollutant concentrations for any freeway cross section and for any wind angle with respect to the freeway.

3. Evaluate other available microscale prediction models.

A research advisory committee was organized so that air quality, atmospheric science, and transportation engineering expertise could all be integrated into a unified, efficient effort. Experts were chosen from the California Air Resources Board, the Los Angeles Air Pollution Control District, the Federal Highway Administration, the University of California faculty, and Caltrans personnel. A complete list is found in Appendix A.

Several potential monitoring sites were established by the advisory committee in the Los Angeles area as shown in Figure 1. Sites were chosen so that the freeway was isolated from other pollutant sources. Data were obtained adjacent to freeways on an earth fill, in a depressed freeway section, and at grade with the surrounding terrain. The wind flow field was also considered in the site selection so that both crosswind and parallel wind data could be obtained.

The main task of this research effort began in July 1971, with approval of the project by FHWA. As shown in Figure 2, the line source model was developed and then modified after comparing the predicted CO values to the measured field values of CO. Also, the tasks of field sampling, probe configuration, and site location were iterative. That is, information gained from the first site was used to refine data collection at later sites.

In order to obtain information concerning the variations in carbon monoxide concentration adjacent to major freeways, a preliminary bag sampling program was initiated. The knowledge gained from this preliminary study enabled the researchers to optimize the configuration of the 15 sampling probes which were available on the mobile research laboratories. Reference 1 is a detailed report discussing this phase of the study.

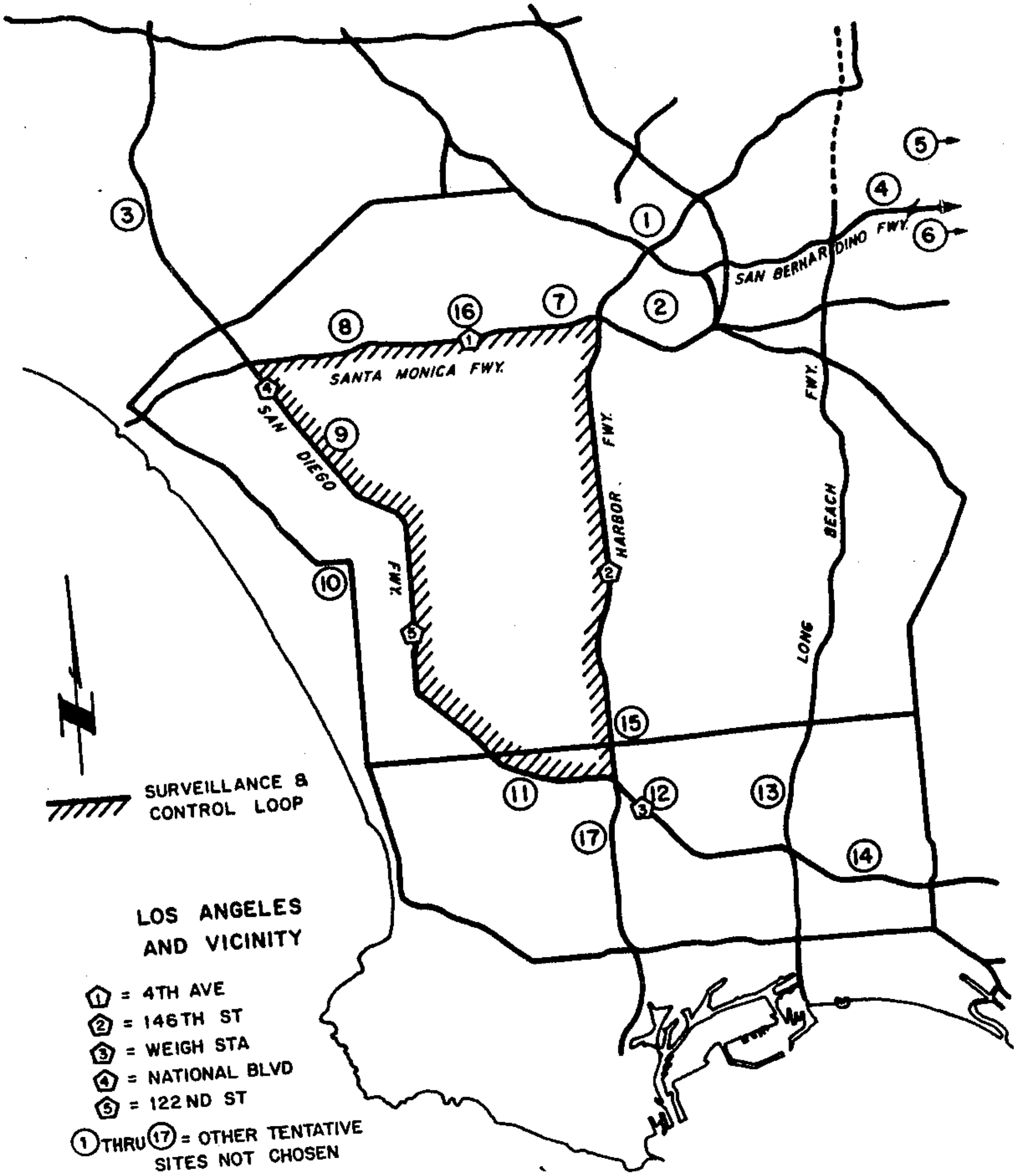


FIG. 1 TENTATIVE AIR QUALITY SAMPLING SITES

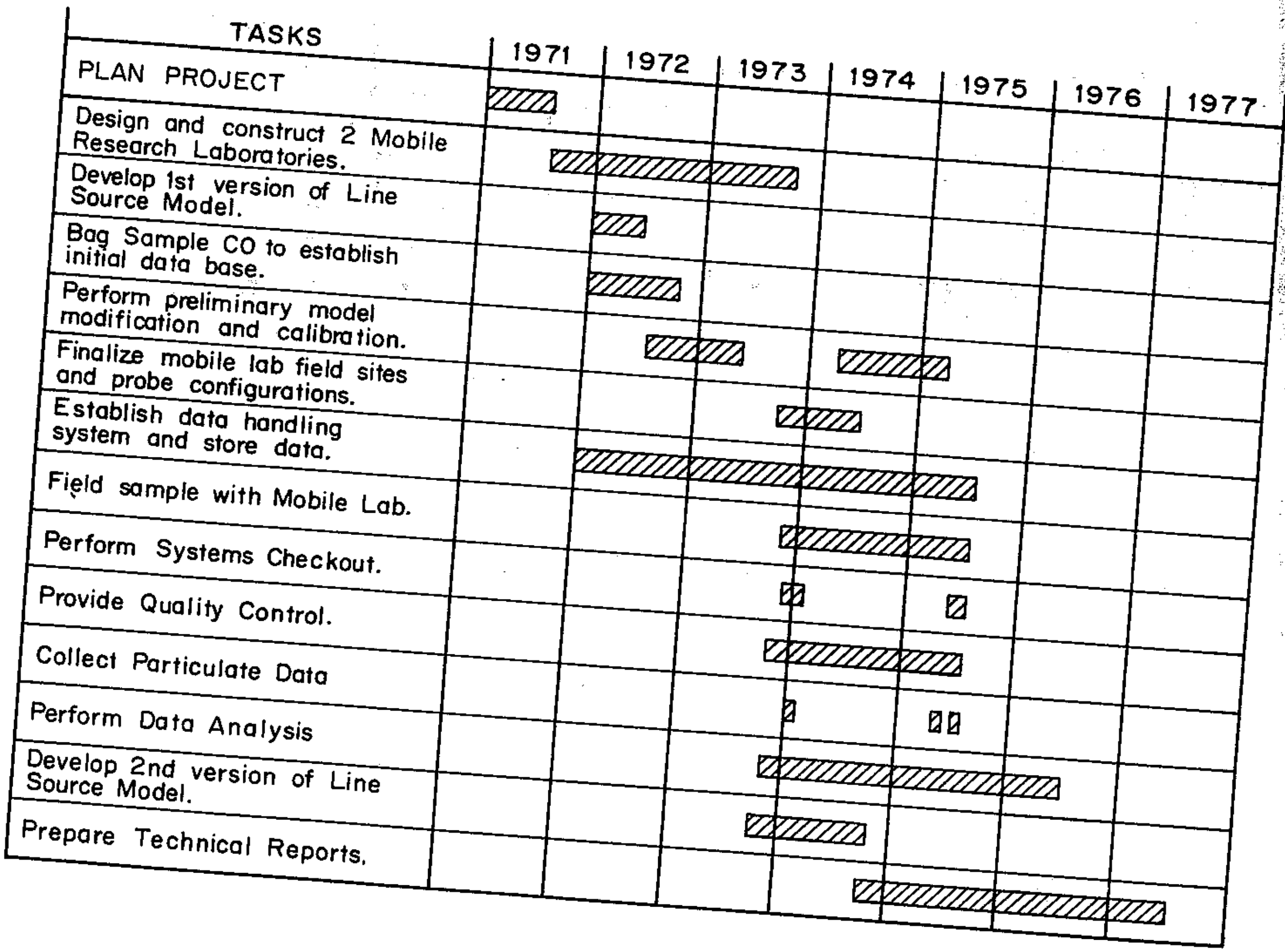


FIG. 2 BAR CHART OF PROJECT ACTIVITIES

A line source prediction model was developed during the early course of this study.. References 2a through 2f provide a detailed description of the line source model and various support activities which can be used in concert to provide air quality impact estimates. After analyzing the data base in Reference 1, the model was improved. Reference 3 documents the revisions to the line source model.

Two mobile research laboratories were constructed using state funds. These fully automated mobile labs were used to collect the majority of the data for this project. Tables 1 through 3 summarize the data that were collected and reduced during the latter phase of this project. A system checkout study was conducted in order to determine whether or not the sampling scheme used by the mobile laboratories had a significant effect on the difference between the recorded and actual pollutant concentrations. A detailed discussion of the study is given in Reference 4.

The sampling was controlled and the analyzer data recorded and summarized by using a mini-computer. An overview of the system software and individual programs used is given in Reference 5.

TABLE 1

MOBILE RESEARCH LABORATORY
GASEOUS POLLUTANT MONITORING AND DATA ACQUISITION

Pollutant Data	Instrument Manufacture & Model Number	Averaging Time	Number of Sampling Points at Site
Carbon monoxide	Beckman 315B NDIR	60 minutes	15
Carbon monoxide	Beckman 6800	15 minutes*	9
Total Hydrocarbons	Beckman 6800	15 minutes*	9
Methane	Beckman 6800	15 minutes*	9
$NO/NO_2/NO_x$	Bendix 8101 B	15 minutes*	9
$SO_2 - H_2S$	Tracor 250-H	60 minutes	1
Ozone	Rem 612	60 minutes	1

*Averaging times for these pollutants are different due to a integrated grab (bag) sample for 15 minutes during each hour. 60 minute averaging is based on multiple readings spaced throughout the hour.

TABLE 2

MOBILE RESEARCH LABORATORY
METEOROLOGICAL DATA ACQUISITION

Meteorological Data	Instrument Manufacturer & Model Number	Averaging Time	Number of Sampling Points at Site
Three-dimensional wind speed and turbulence	Climet	60 minutes	2
Wind Shear	Climet	60 minutes	1
Temperature	Climet	60 minutes	2
Temperature over a vertical span of 17 feet	Climet	60 minutes	2
Ancoming Ultraviolet radiation	Eppley No 647a	60 minutes	1

TABLE 3

MISCELLANEOUS DATA ACQUISITION

	Averaging Time	Number of Sampling Points at Site
Traffic Data		
Traffic Volumes (Radar)	60 minutes	8
Traffic Speeds (Radar)	60 minutes	8
Traffic Volumes (Loop Detectors)	60 minutes	2
Traffic Speeds (Loop Detectors)	60 minutes	2
Particulate Data		
Total Particulates (Hi-Vol Sampler)	120 minutes*	4
Lead (Hi-Vol Sampler)	120 minutes*	4
Total Particulates (Lundgren Impactor)	120 minutes*	4-5
Various elements (Lundgren Impactor)	120 minutes*	4-5
Meteorological Data		
Cloud Cover (L.A. Airport)	Hourly Readings	-0-
Ceiling Height (L.A. Airport)	Hourly Readings	-0-

*Averaging times for particulate data is based on a two hour time period to enable the obtaining of a significant size sample yet allow a time period which was short enough to demonstrate loading cycles vs. time of traffic occurance.

SUMMARY OF RESEARCH FINDINGS

The primary goal of this study was to establish an extensive data base to be used for the development and validation of microscale air pollution models. This data base has been established and should prove an important resource for future microscale modeling work. It includes data for the following gaseous pollutants: CO, CH_4, RHC, NO_x, O_3, H_2S and SO_2. It also contains detailed meteorological data including wind speeds and temperatures at two heights, incoming solar radiation flux, wind direction and directional variability.

Preliminary results from bag sampling operations (prior to establishing the data base) led to an improved version of the California Line Source Dispersion Model, CALINE 2. This improved version incorporated significant adjustments to predictions made for depressed sections.

Other results showed that CO and NO_x follow very similar vertical dispersion patterns while total hydrocarbons diffuse more slowly above the roadway. Lapse rates were shown to be generally more unstable over roadways than adjacent areas. Ambient levels of CO tended to be reached 300 feet (91 meters) from the edge of the pavement in urban areas and 400 feet (122 meters) in rural areas under stable atmospheric conditions. On this project lead particles seemed minute enough to not undergo significant gravitational settling within 1,000 feet (305 meters) of the roadway, and modeling lead as a gas yielded results with reasonable accuracy.

Interim reports issued in connection with this project include:

1. "Air Pollution and Roadway Locations, Design, and Operation - Preliminary Carbon Monoxide Study" by Shirley, Ranzieri, and Bemis, May 1975.

2. "Minicomputer Software Data Acquisition and Process Control System for Air Pollution Monitoring" by Winter and Farrockrooz, May 1976.

3. "CALINE2, An Improved Microscale Model for the Diffusion of Air Pollutants from a Line Source" by Ward, Shirley, and Ranzieri, November 1976.

4. "Variables Affecting Air Quality Instrument and Operation" by Peter, Pinkerman, and Shirley, June 1977.

EVALUATION OF WIND FLOW FIELD

An evaluation of the wind flow field (wind speed and direction) in the Los Angeles portion of the South Coast Air Basin was performed in order to isolate geographical locations where (1) winds tend to be parallel to the highway alignment, (2) winds tend to cross the highway alignment. This information was used as an aid in selecting the field sites for the study.

The data used in this analysis were obtained from both the Los Angeles Air Pollution Control District (5 years of data) and the National Weather Service at the Los Angeles International Airport (10 years of data). This data set was supplemented with data obtained by the use of mechanical weather stations (MWS) operated by Caltrans.

The wind speed and direction data were summarized into frequency distribution tables. In order to have a feel for the prevailing wind speeds and directions associated with peaks in directional vehicular traffic flow, summaries were made for the hours of:

1. 0600 - 0900 (a.m. period)
2. 1100 - 1300 (midday period)
3. 1600 - 1800 (p.m. period)

From these frequency distribution tables, surface streamlines were obtained (Figures 3 to 8). Figure 3 illustrates the general flow of the land and drainage winds during the winter. This is primarily caused by the difference in temperature between land and the ocean. These land winds generally range from 4 to 6 mph (2 to 3 m/sec) at the coastline decreasing somewhat inland. During these periods, the surface atmospheric conditions are generally stable and ground level concentrations of primary pollutants may be high. Figures

4 and 5 illustrate the general flow of the sea breeze regime during the winter. This again is primarily caused by the difference in temperature of the ocean and land. The sea breezes generally blow at speeds of 8 to 10 mph (4 to 4.5 m/sec) along the coastline and decrease somewhat inland. Figures 3 and 4 also illustrate the topographic effects that the Palo Verdes Hills have on the surface air flow.

Figures 6 through 8 indicate typical conditions that exist during the summer months. The morning periods (a.m.) are generally associated with light winds varying in direction. This is the transition period in which the land breeze is changing to a sea breeze regime. Figures 7 and 8 illustrate the strong summer sea breezes generally ranging from 10 to 15 mph (4.5 to 7 m/sec) at the coastline and decreasing somewhat inland.

Based upon the wind flow field information, potential sampling sites were categorized as tending to be a crosswind or parallel wind site. The upwind and downwind sides of the sites were also established. This information was then used as a factor in the selection of field sampling sites and design of the probe configurations for the sites chosen.

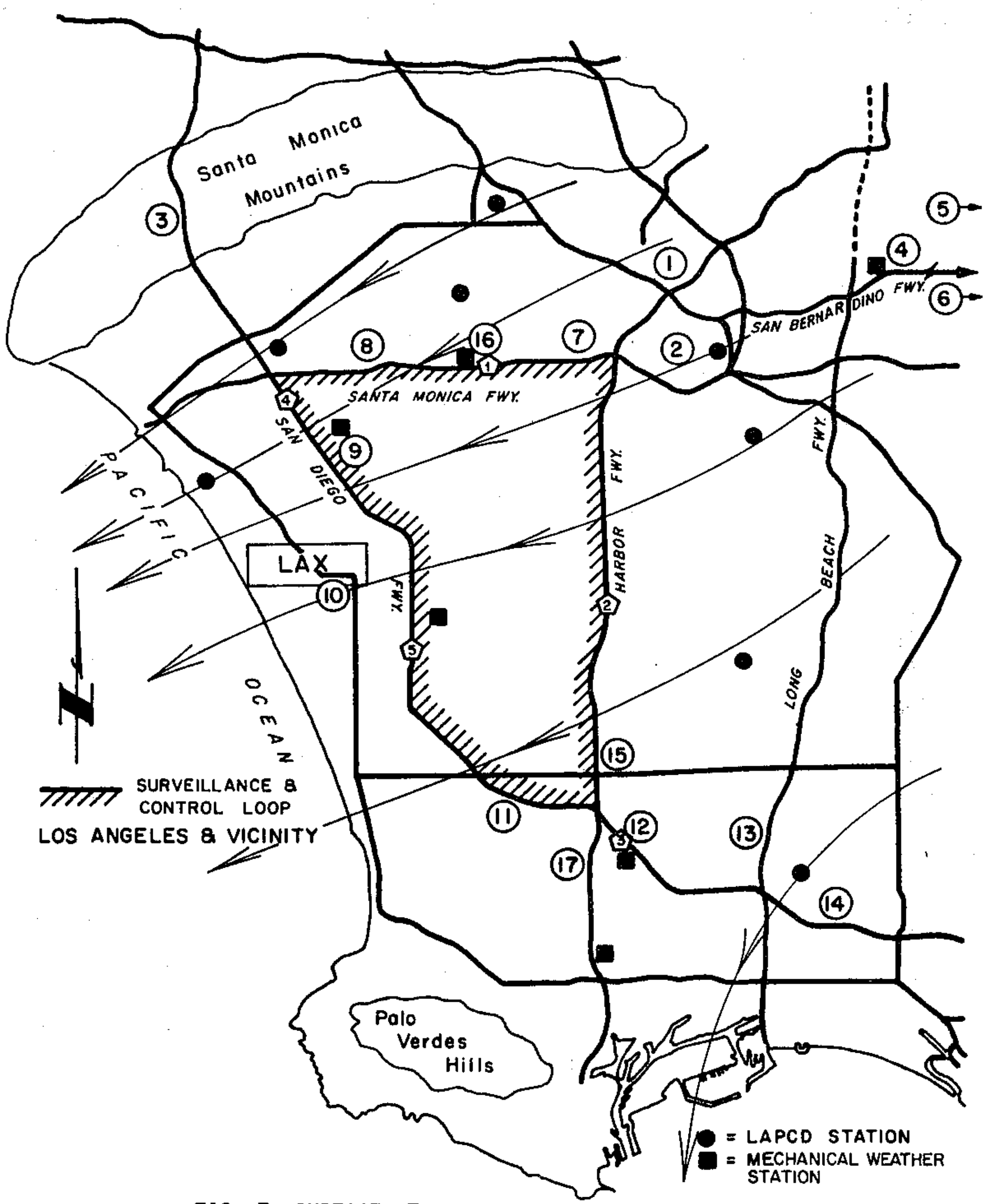


FIG. 3 SURFACE STREAMLINES FOR DECEMBER AM

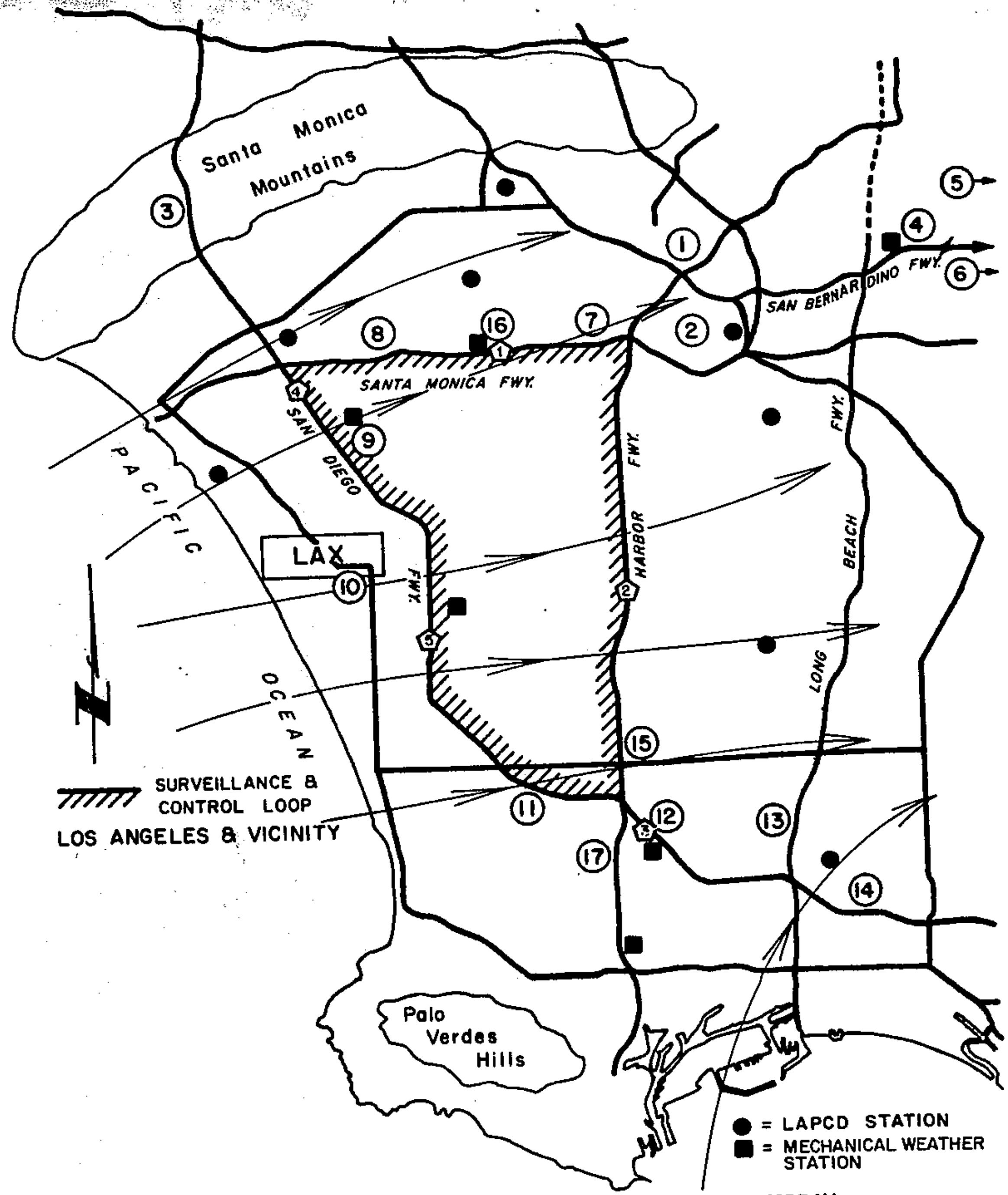


FIG. 4 SURFACE STREAMLINES FOR DECEMBER MIDDAY

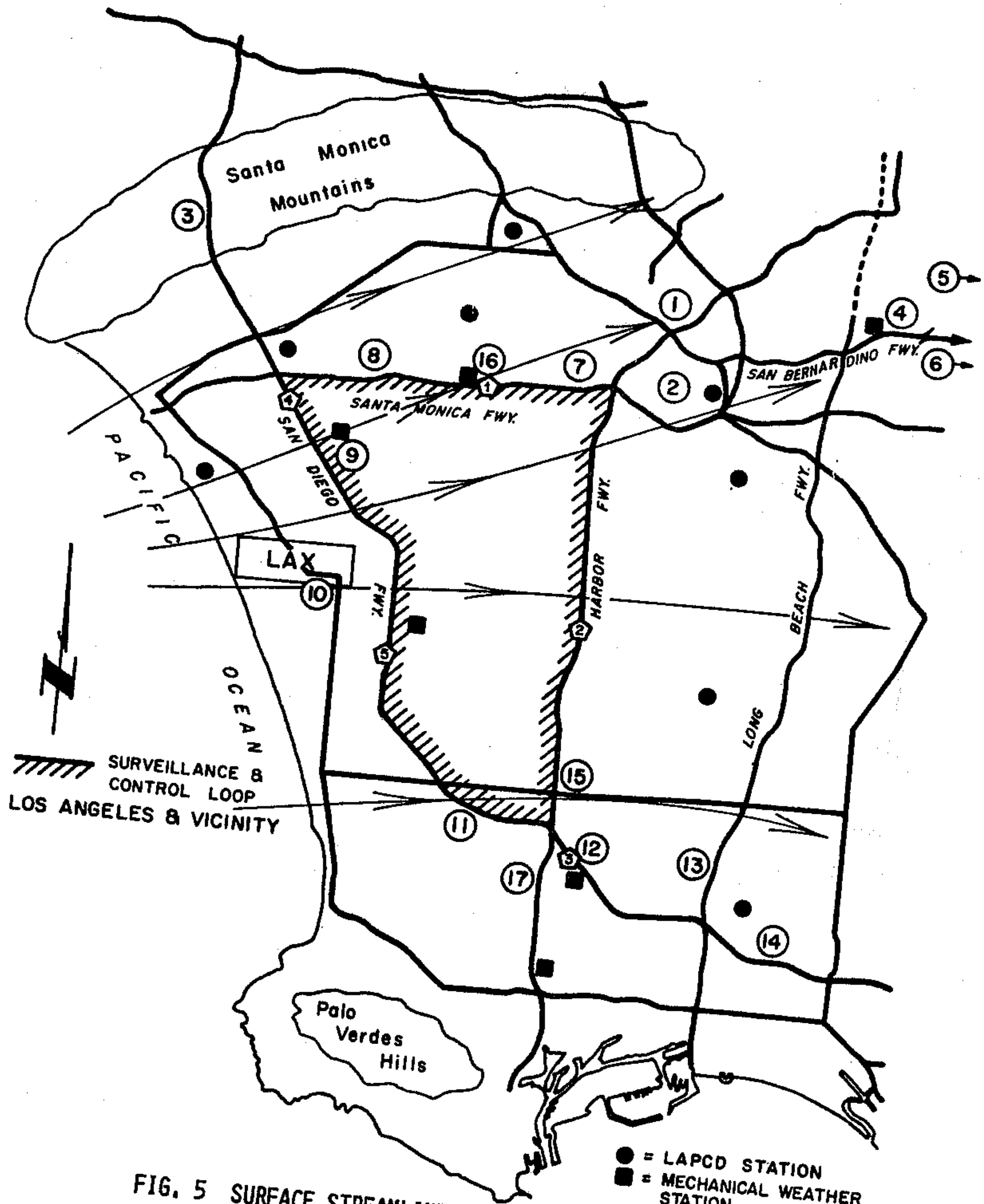


FIG. 5 SURFACE STREAMLINES FOR DECEMBER PM

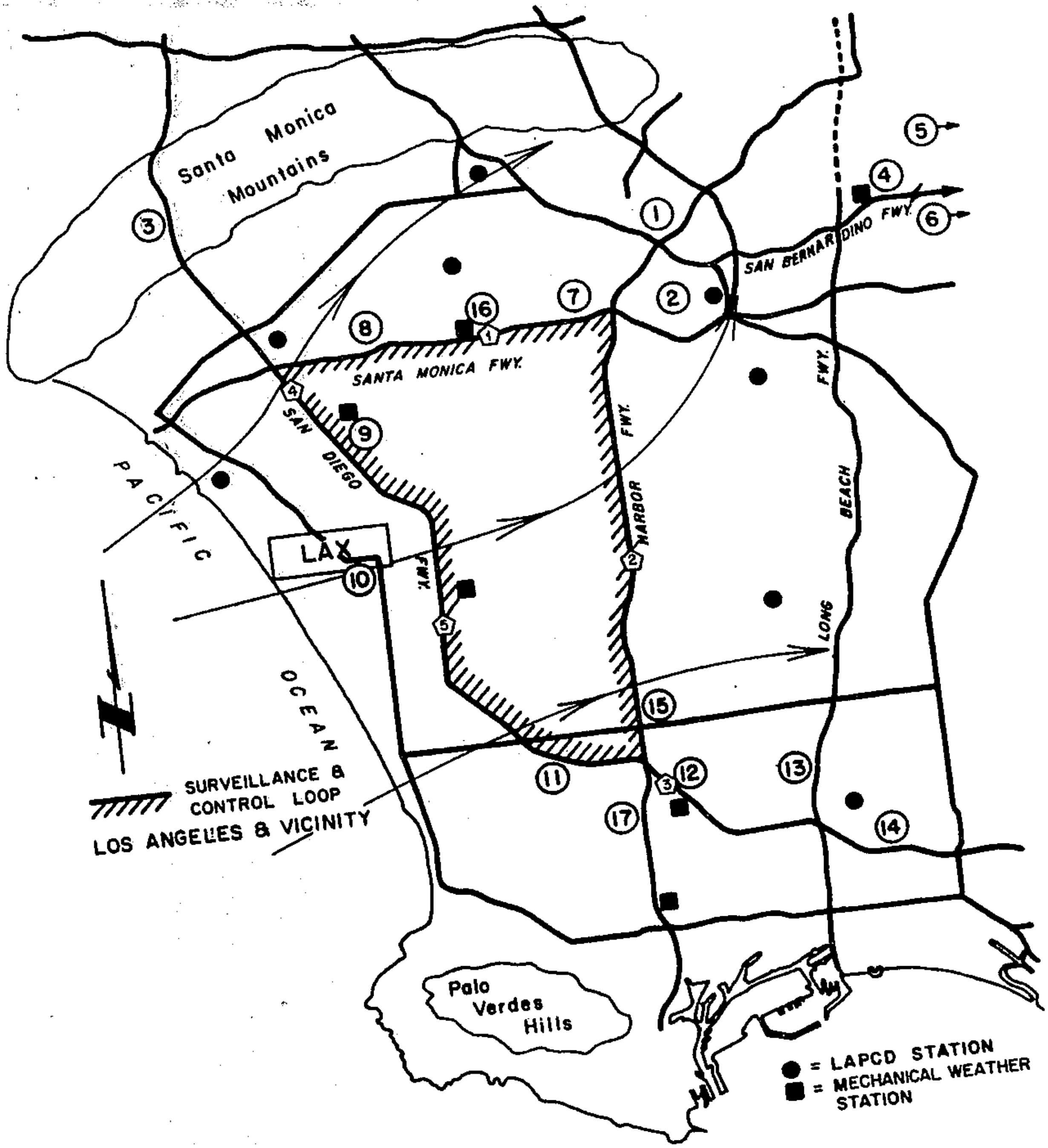


FIG. 6 SURFACE STREAMLINES FOR AUGUST AM

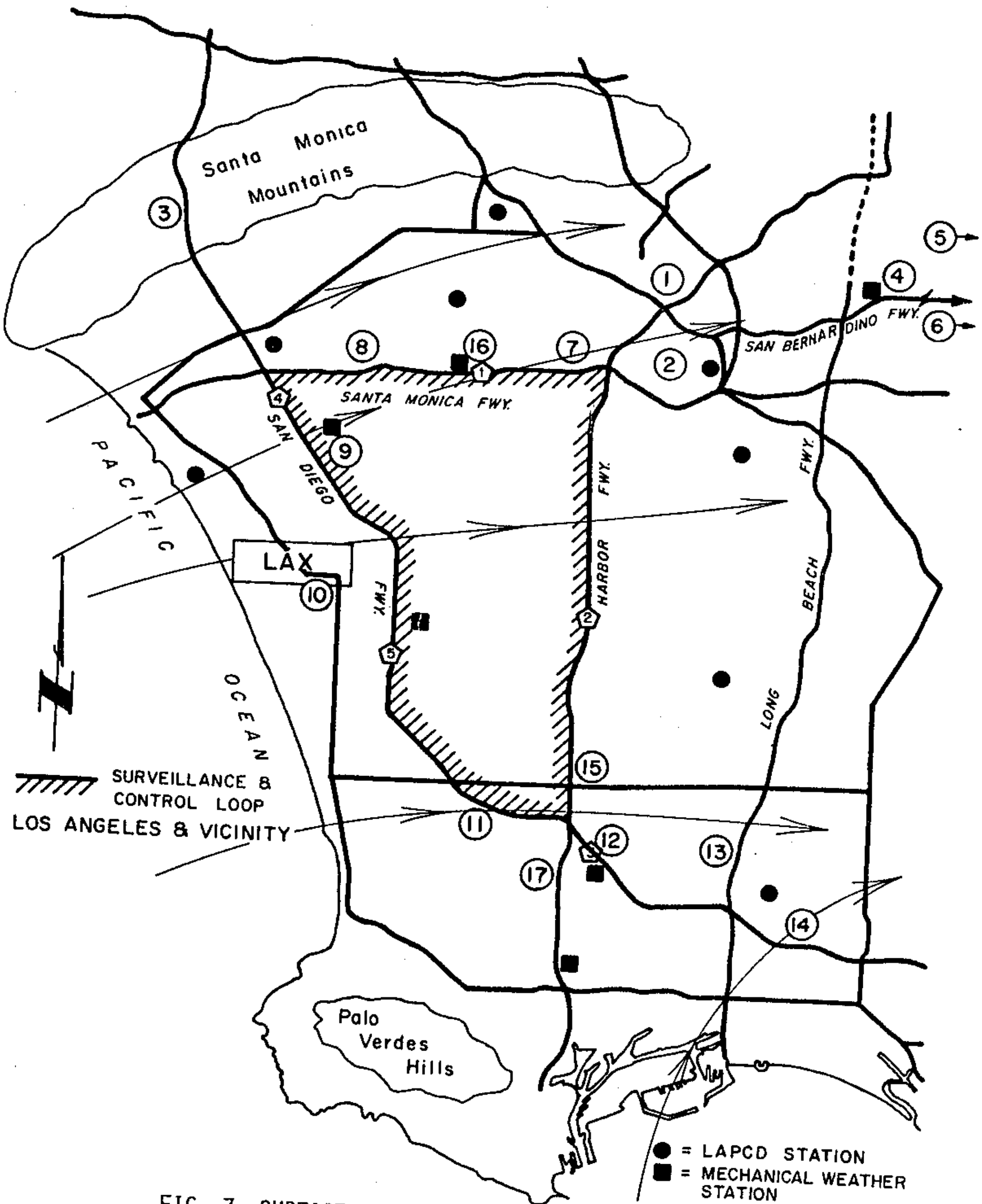
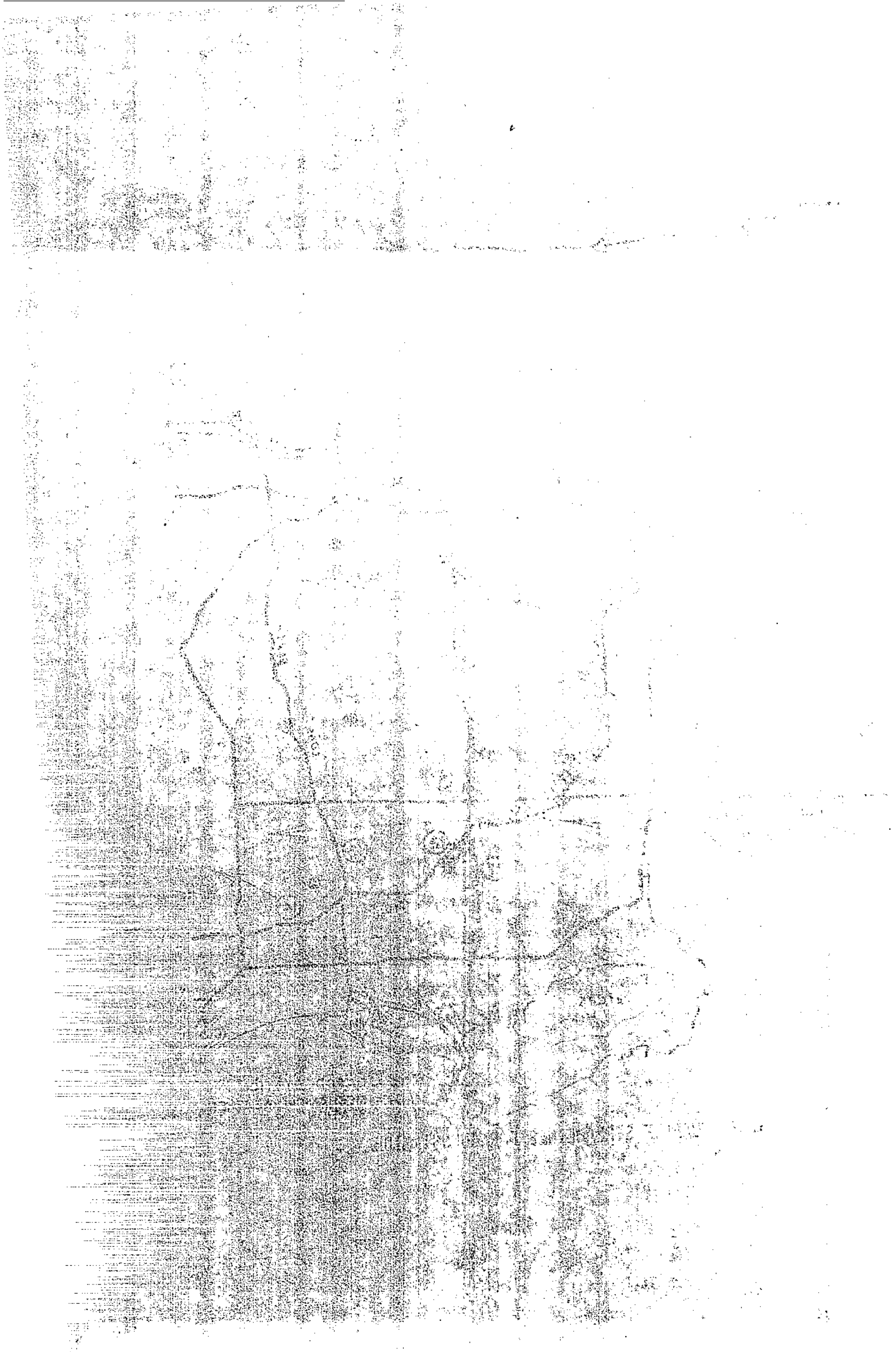


FIG. 7 SURFACE STREAMLINES FOR AUGUST MIDDAY



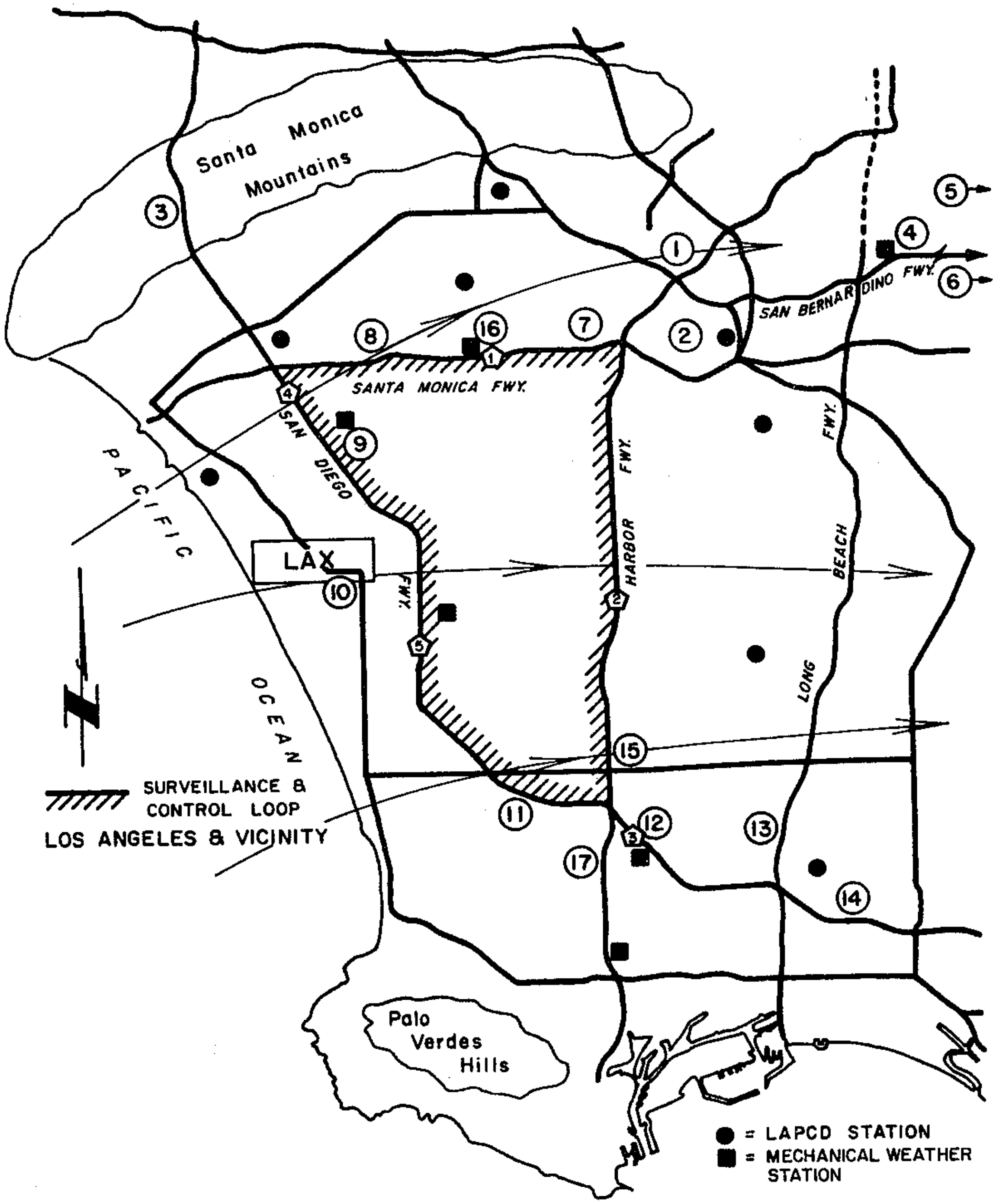


FIG. 8 SURFACE STREAMLINES FOR AUGUST PM

SITE SELECTIONS

The following is a brief discussion of the various types of highway designs considered in the site selection procedure:

1. At Grade Sections

The roadway is at the same elevation as the surrounding land. This can lead to fairly high pollutant concentrations (all other factors being constant) due to the close proximity of the source of pollutants to the receptors.

2. Fill Sections

The roadway is raised above the adjacent land on an earth fill. This type of highway design can lead to possible reduced ground level pollutant concentrations downwind. The elevated pollutant source tends to be more adequately ventilated reducing the concentrations for both the motorist and the receptor on the adjacent land. Special consideration was made to evaluate pollutant concentrations near the downwind toe of the fill due to a reverse eddy generated by strong winds.

3. Depressed Sections

The roadway is continually bounded on both sides by an earth cut. Pollutants are confined laterally restricting dispersion within the zone bounded by the cut. This may cause pollutants to buildup on the roadway under parallel wind conditions. However, this has not been observed to date(1). Ground level receptors may receive reduced pollutant concentrations because of the larger cell in which mechanical mixing attributable to vehicle generated turbulence takes place.

As mentioned in the previous section, a wind flow field analysis was performed to determine the prevailing wind speeds and directions. In addition, each potential site was evaluated to determine the feasibility of sampling at that particular site. It was imperative to have sites where the pollutants under study could be isolated from external sources. Side streets and frontage roads contribute relatively minimal amounts to the atmospheric concentration of the pollutants near the freeway and were assumed to have negligible effects. Large industrial sources and airports could have easily overshadowed freeway emissions at a specific site and were therefore avoided.

Another consideration for site selection was adjacent land use. Of importance was the nature of the land use and the physical heights, shapes and spacing of obstructions. Such factors have a measurable effect on wind flow and surface stability. Both single story residential and two story residential sites were selected. These sites provided data from areas having aerodynamic roughness characteristics representative of urban conditions, where most pollutant predictions are made for impact analyses. Open, semirural sites, where the surface roughness elements are small, were also included since most dispersion parameters currently used to characterize downwind spread of pollutants have been obtained from study of such areas.

Still another consideration was logistics. The sites had to be easily accessible for field personnel. Structures such as freeway signs, light poles and pedestrian overcrossings were required in order to support the meteorological instrumentation and pollutant probes. Sites also needed room for the mobile research laboratory, when employed. Disruption of local traffic patterns was to be avoided.

- data base gleaned from the Los Angeles sampling project -ld be of little value without traffic data. For this ason, it was very desirable that the sampling sites be long the "surveillance loop". The surveillance loop is a iangle shaped freeway loop, 42 miles (67.2 Km) min length consisting of the Santa Monica Freeway (12.7 miles [20.3 Km]) on the north, the San Diego Freeway (16.6 miles [26.6 Km]) on the west, and the Harbor Freeway (12.7 miles [20.3 Km]) on the east. The map on Figure 1 includes the surveillance loop.

The surveillance loop has frequently spaced traffic counters in order to measure traffic speed and volume. These counters divide the loop into links that can be isolated for traffic study. There are 28 traffic links on the Santa Monica Freeway, 32 links on the San Diego Freeway, and 25 links on the Harbor Freeway.

Based on the preceeding criteria, five experimental sites were initially selected. The following is a description of each site and the reasons for its selection.

<u>Site 1 - Santa Monica Freeway at 4th Avenue Pedestrian Overcrossing</u>

This site is a typical example of a depressed freeway section located in the urban area. The depth of cut is 24 feet (7.3 meters). Figure 9 shows the geometrics of the section. This section consists of a 10 lane freeway with two on and off ramps for a total of 12 lanes. The site is representative of a highway located within a mixed single-double story residential area. The heights of the dwellings range from 20 to 30 feet (6.1 to 9.1 meters) above the ground surface. The highway alignment is essentially an east-west direction (bearing N 80° 12' 53" E). Based on surface wind streamline analysis, this section has prevailing surface winds (sea breeze) generally parallel to the highway alignment from about midday through sunset. This allowed study of parall wind buildup effects. In the morning, typical land breezes generally occur over the area. This land breeze is general a crosswind with respect to the highway alignment so that th site had both parallel and crosswind conditions occurring alternately.

The site is far removed from any other localized pollutant oource. There are no freeways or main surface streets in the immediate area which could generate additional pollutants to interfere with the study. Emissions from surrounding residences are minor compared to the freeway generated pollutants because the site is located at the end of a cul-de-sac. There is a pedestrian overcrossing which facilitates access to monitoring devices on both shoulders and in the median of the highway. Samples can be readily taken along the residential street to monitor the horizontal dispersion of pollutants.

There is adequate room to park the mobile research laboratory. The site is part of the Surveillance Loop Project from which traffic volume and speed estimates can be obtained. Figures 10 through 14 illustrate the configuration of the sampling probes during various phases of the study. Pictures of this site and surrounding area are shown in Figures 15 through 17.

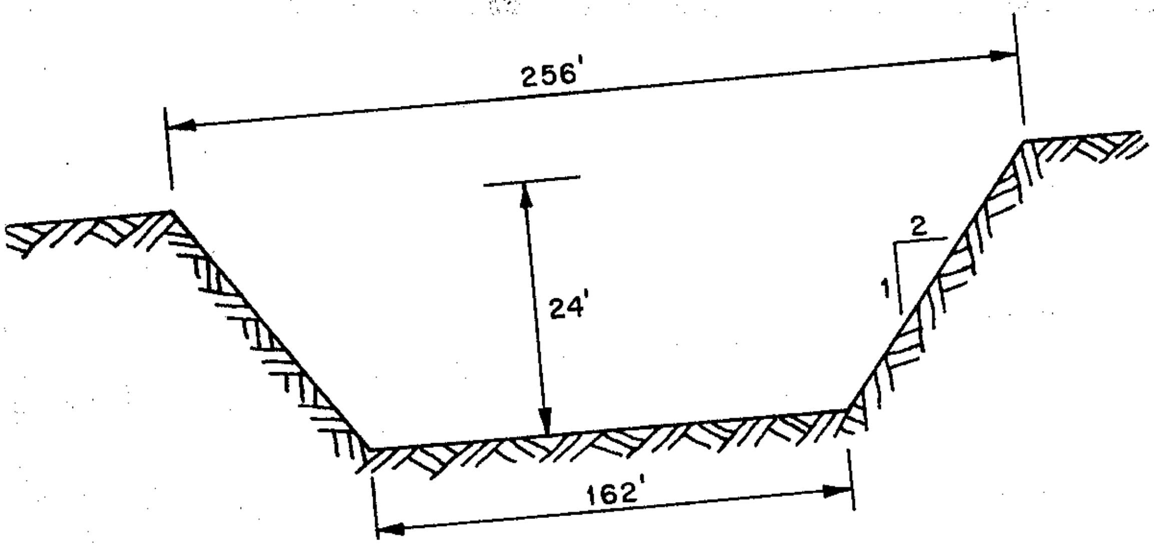


FIG 9 GEOMETRICS OF SITE 1--SANTA MONICA FREEWAY AT 4TH AVE PEDESTRIAN OVERCROSSING
(NOT TO SCALE)

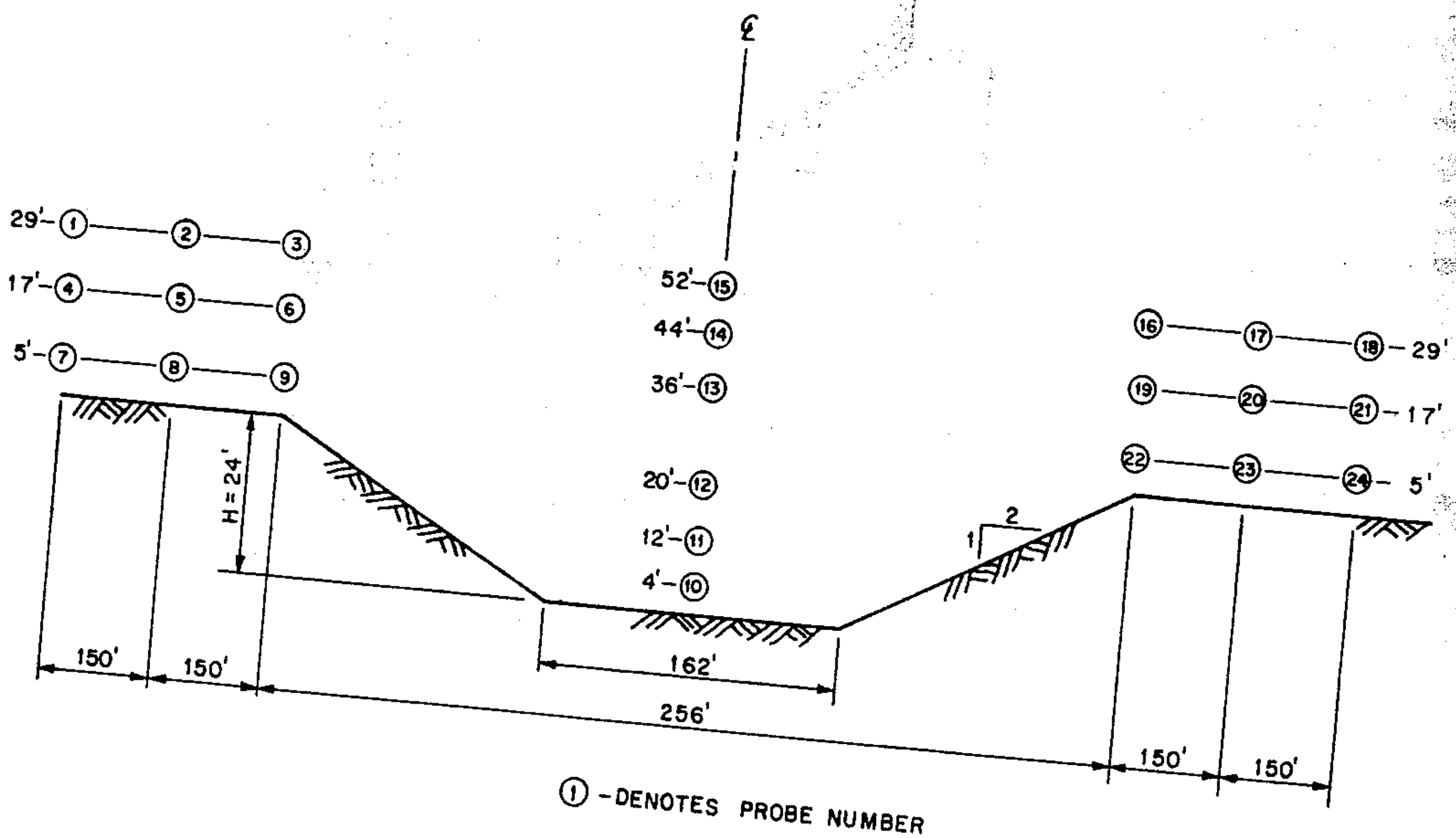
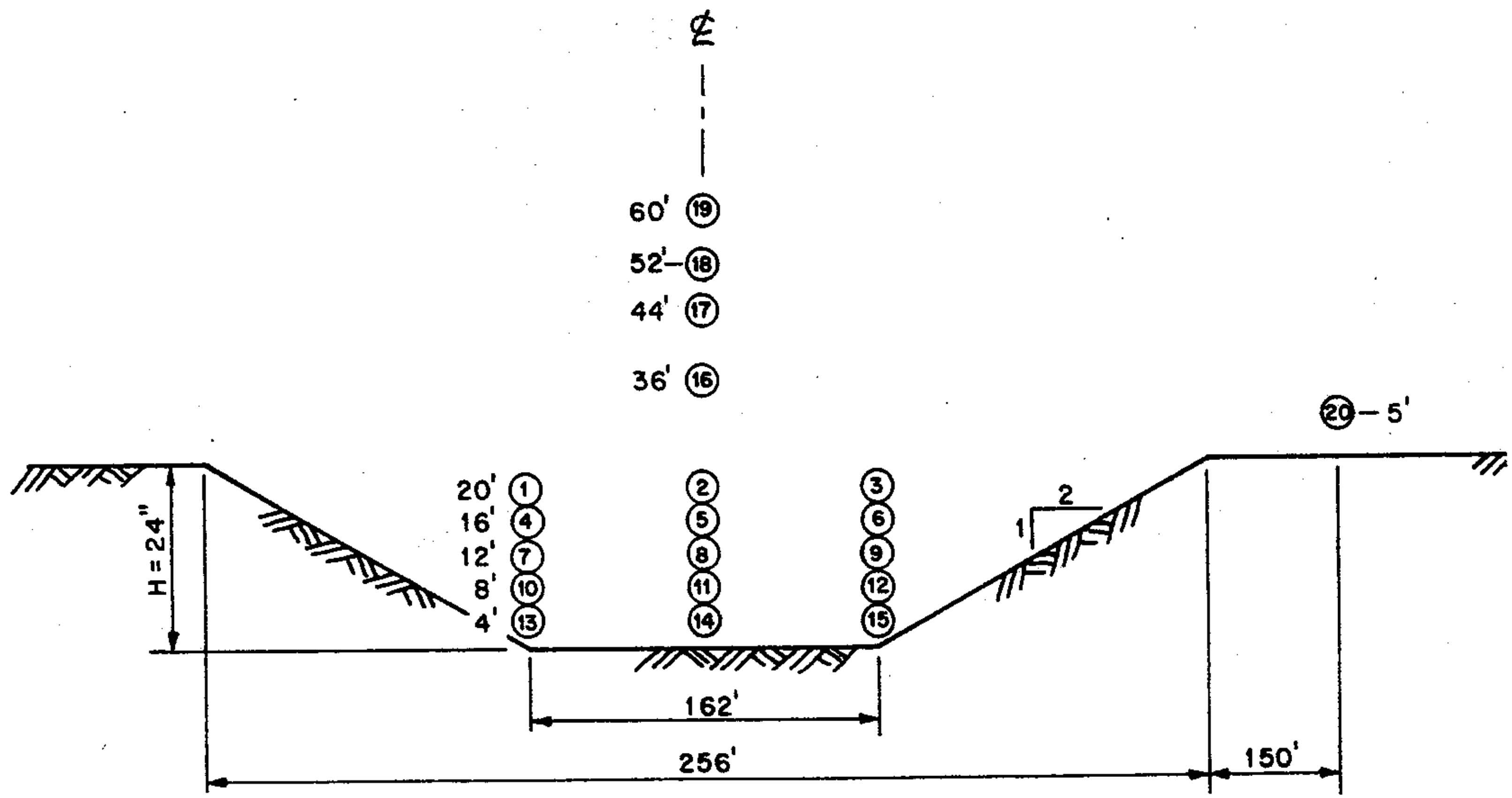


FIG. 10 PROBE LOCATIONS, SANTA MONICA FREEWAY (SITE I) AT 4TH AVE P.O.C. DOWNWIND STUDY (1972)
(NOT TO SCALE)



1 -DENOTES PROBE NUMBER

FIG. 11 PROBE LOCATIONS, SANTA MONICA FREEWAY (SITE I) AT 4TH AVE P.O.C. IN-SECTION STUDY (1972)

(NOT TO SCALE)

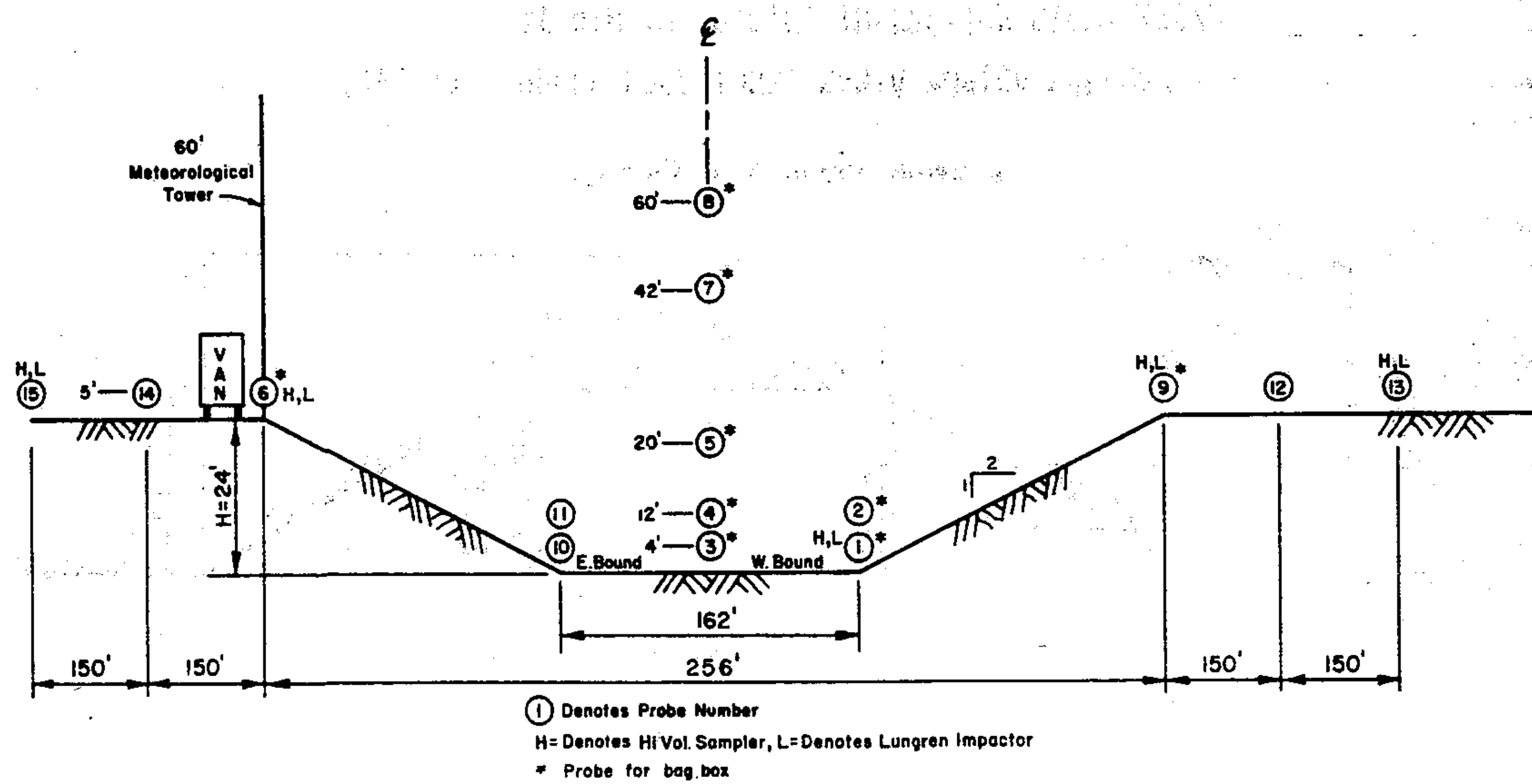
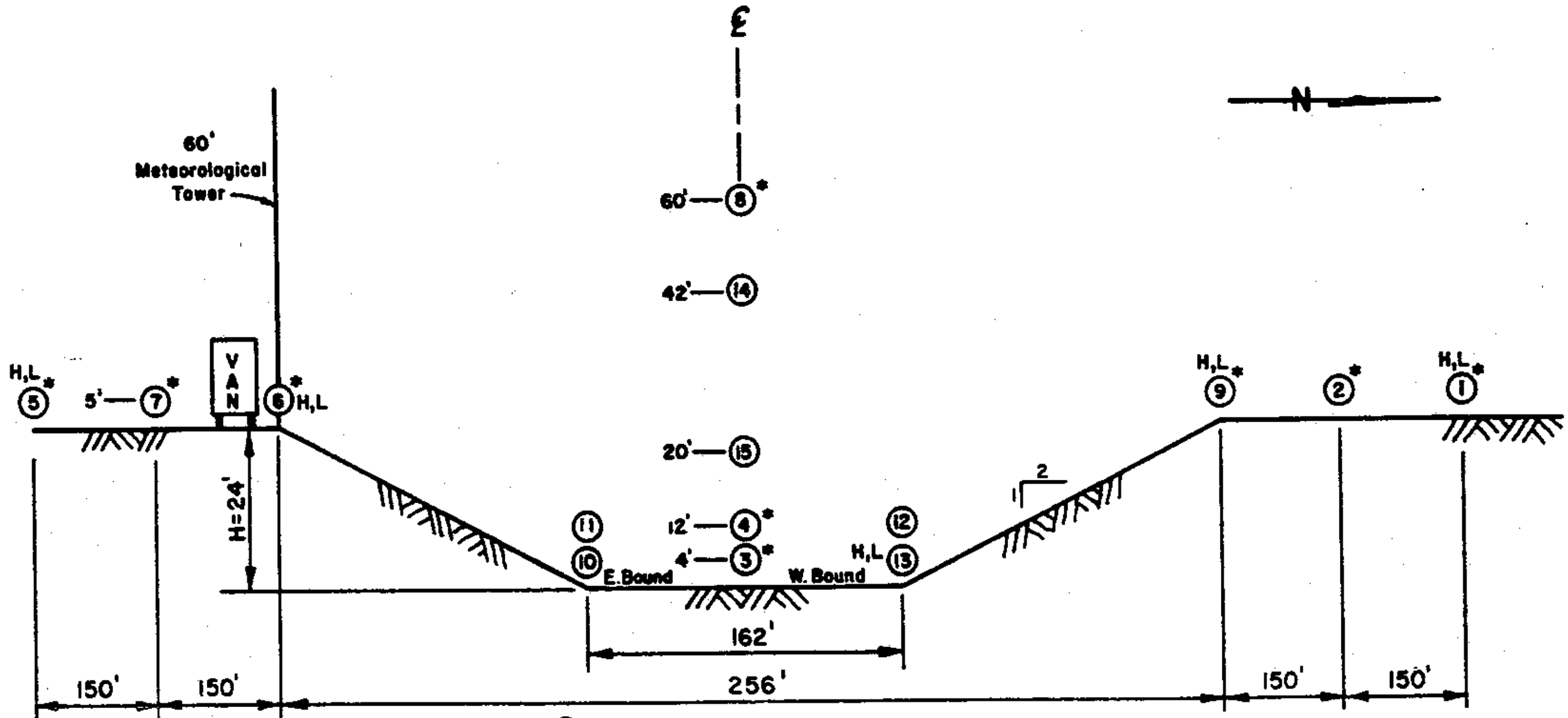


FIG. 12 PROBE LOCATIONS (SITE I)
SANTA MONICA FWY. AT 4TH AVE. P.O.C.
NOV. 1, 1973 TO JUNE 12, 1974
(NOT TO SCALE)



(1) Denotes Probe Number
H=Denotes Hi Vol. Sampler, L=Denotes Lundgren Impactor
* Probe for bag box

FIG. 13 PROBE LOCATIONS, (SITE I)
SANTA MONICA FWY. AT 4TH AVE. P.O.C.
JUNE 13, TO JULY 19, 1974
(NOT TO SCALE)

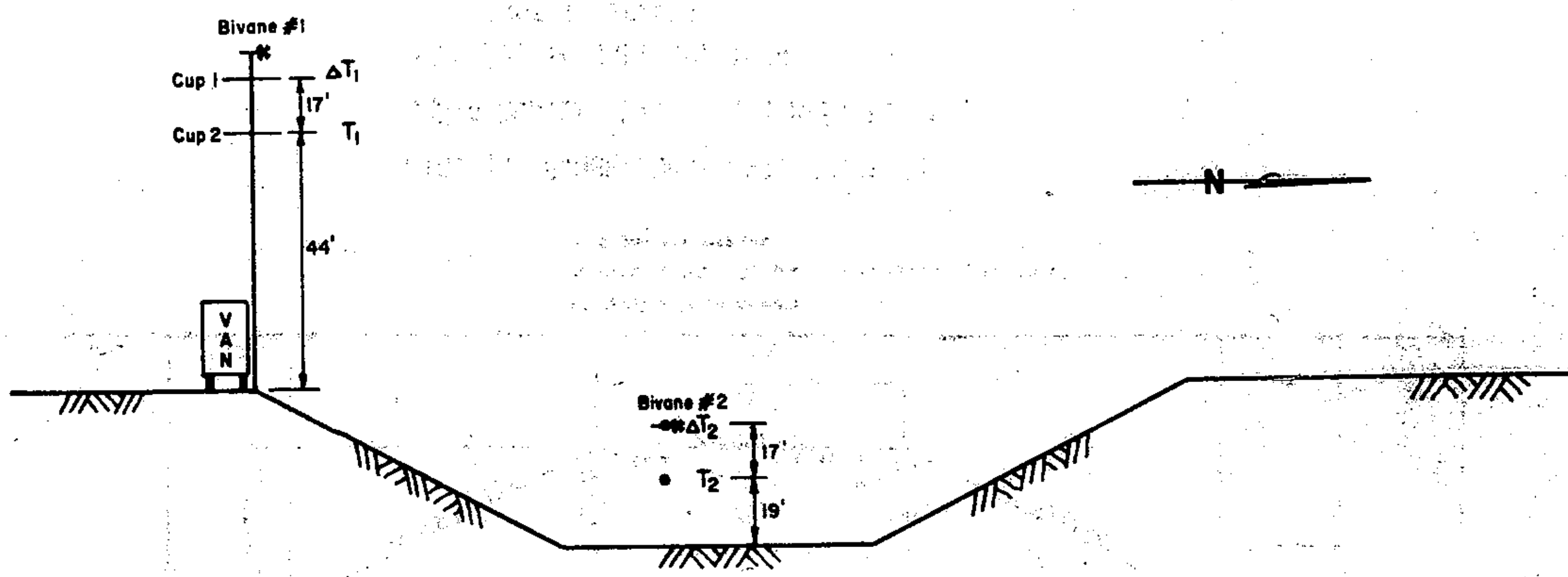


FIG. 14 METEOROLOGICAL INSTRUMENTATION (SITE I)
SANTA MONICA FWY. AT 4TH. P.O.C.
(1973-74)

(NOT TO SCALE)

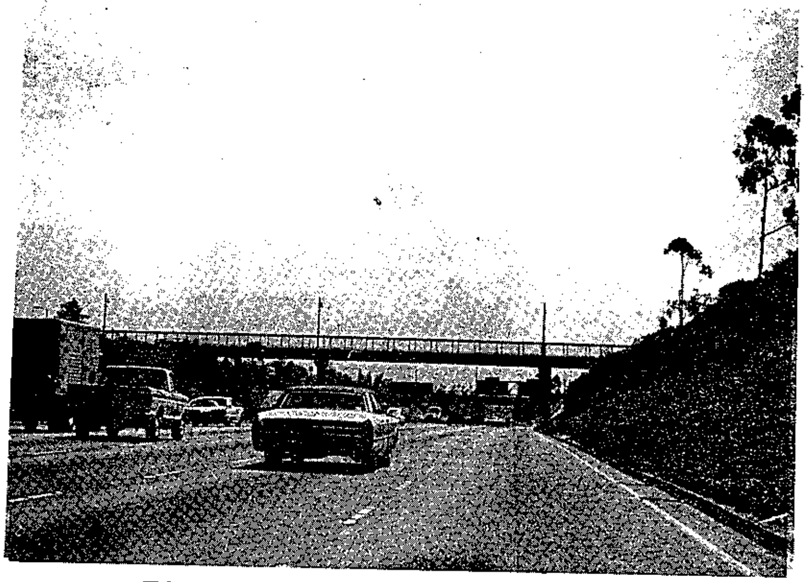


Figure 15 View of Site 1 From Freeway Looking East

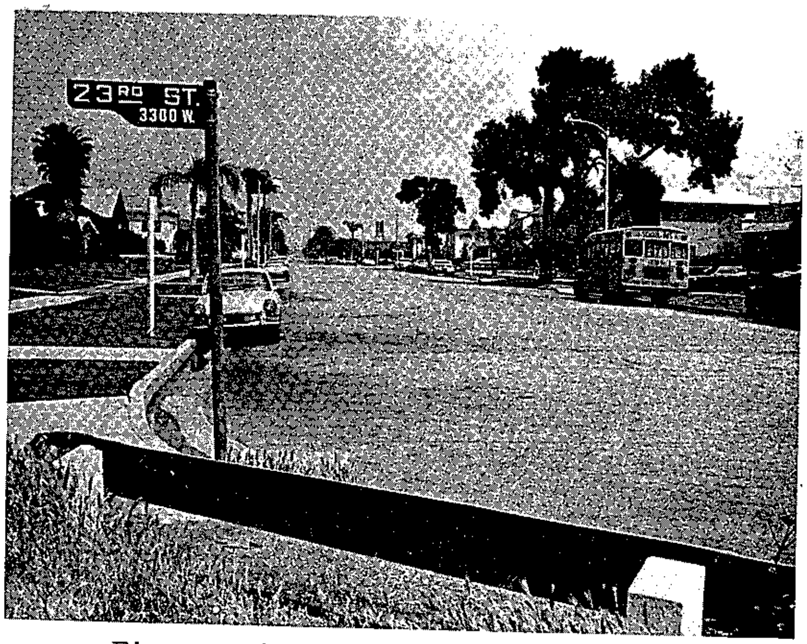


Figure 16 View of Site 1 Looking North and Away From Freeway

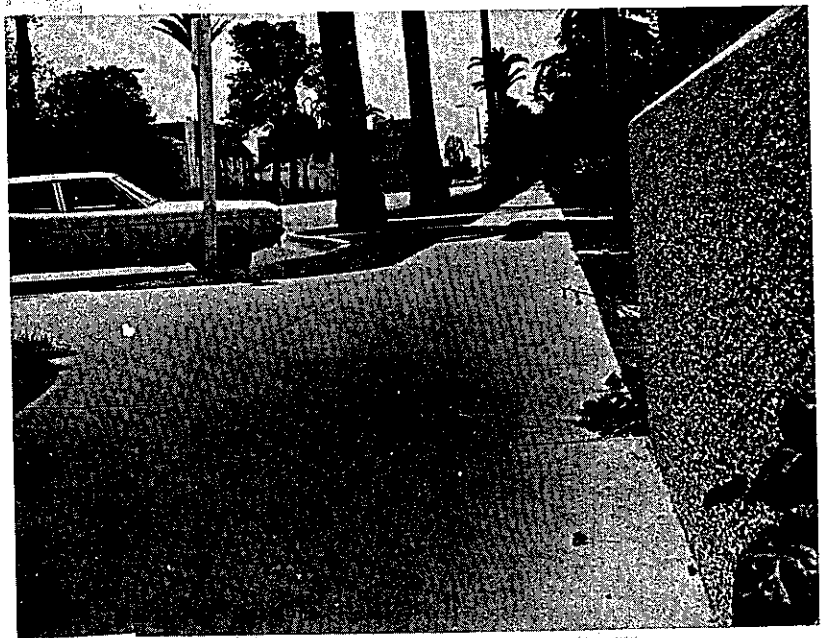


Figure 17 View of Site 1 Looking
South and Away From Freeway

Site 2 - Harbor Freeway at 146th Avenue Pedestrian Overcrossing

This site is a typical 8 lane urban depressed section. Figure 18 shows the geometrics of the section. This site is representative of a highway located within a single story residential area. The average height of dwellings ranges from 15 to 20 feet (4.6 to 6.1 meters) above the ground surface. The highway alignment is essentially a north-south direction (bearing N 00° 06' 57" E). One of the most important reasons for selecting this site is that the prevailing sea breeze is nearly normal to the highway alignment. This permits evaluation of aerodynamic effects on air flow within the cut section (see Figure 19), the resulting impact on pollutant concentrations on the freeway, and the downwind dispersion of pollutants characteristic of this type of site under crosswind conditions. Also, the site can be compared to Site 1 for differences of pollutant concentrations between parallel and crosswind conditions at the same time of day.

This site is located at the end of a cul-de-sac which minimizes outside pollutant sources. The pedestrian overcrossing and residential street provide access to sensors both on the shoulder and median of the highway and in the downwind direction to study the dispersion of pollutants. This site is also located on the Surveillance Loop Project. Figures 20 and 21 illustrate the configuration of the sampling probes during various phases of the study. Pictures of the site and surrounding area are shown in Figures 22 through 24.

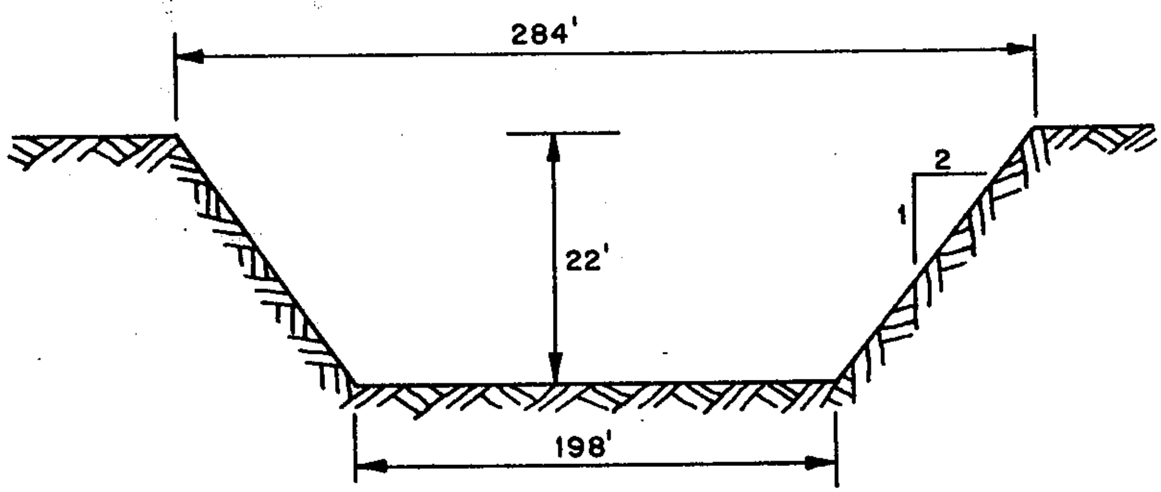


FIG. 18 GEOMETRICS OF SITE 2 -- HARBOR FREEWAY AT 146TH ST. PEDESTRIAN OVERCROSSING

(NOT TO SCALE)

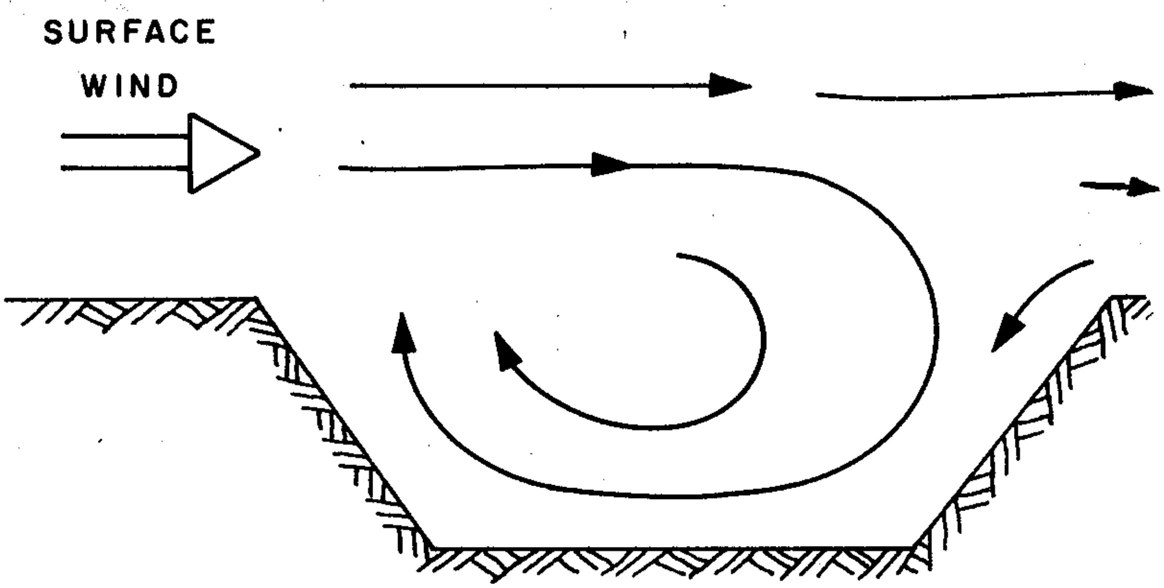


FIG. 19 AERODYNAMIC EDDIES IN DEPRESSED SECTION

(NOT TO SCALE)

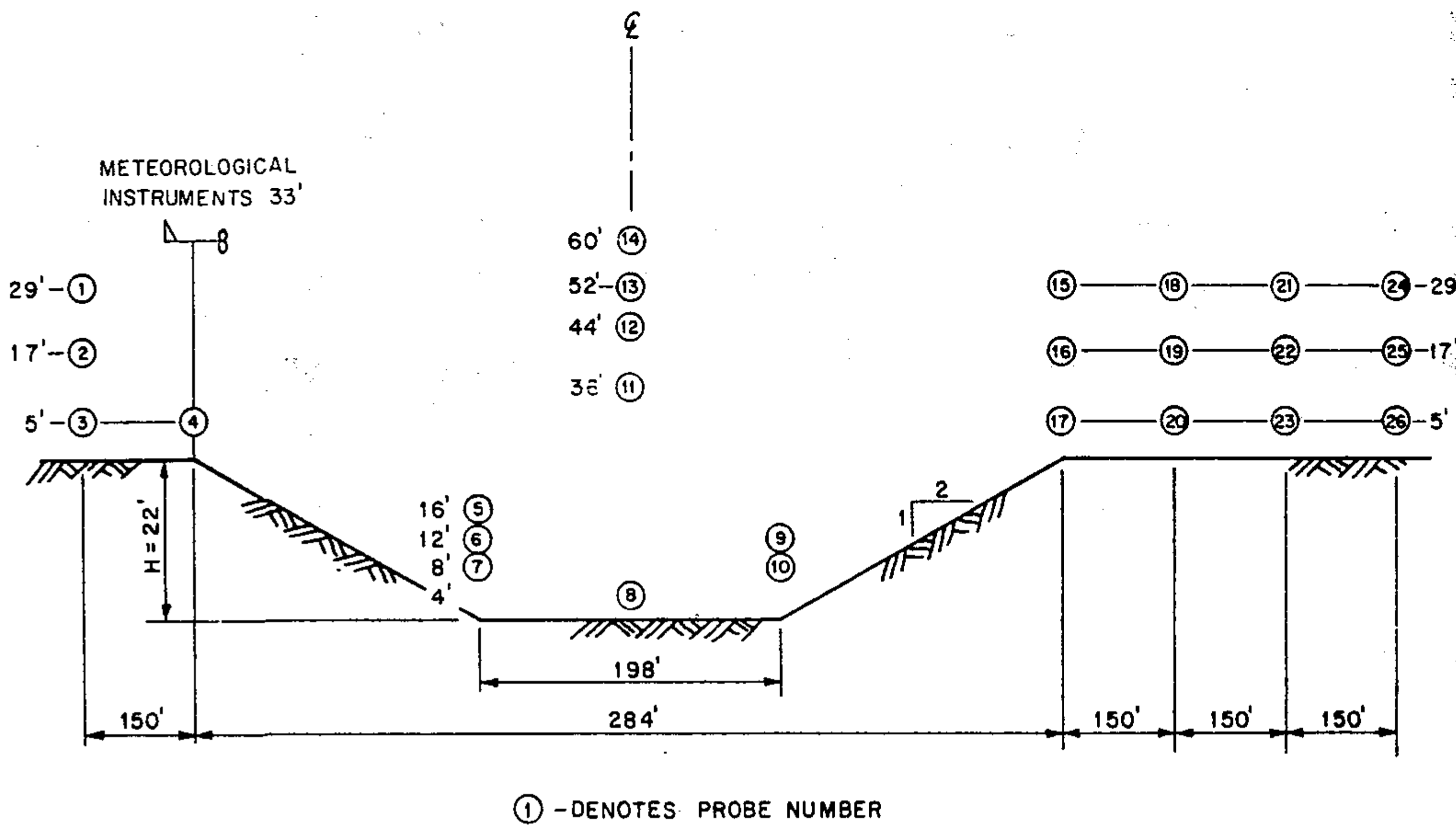
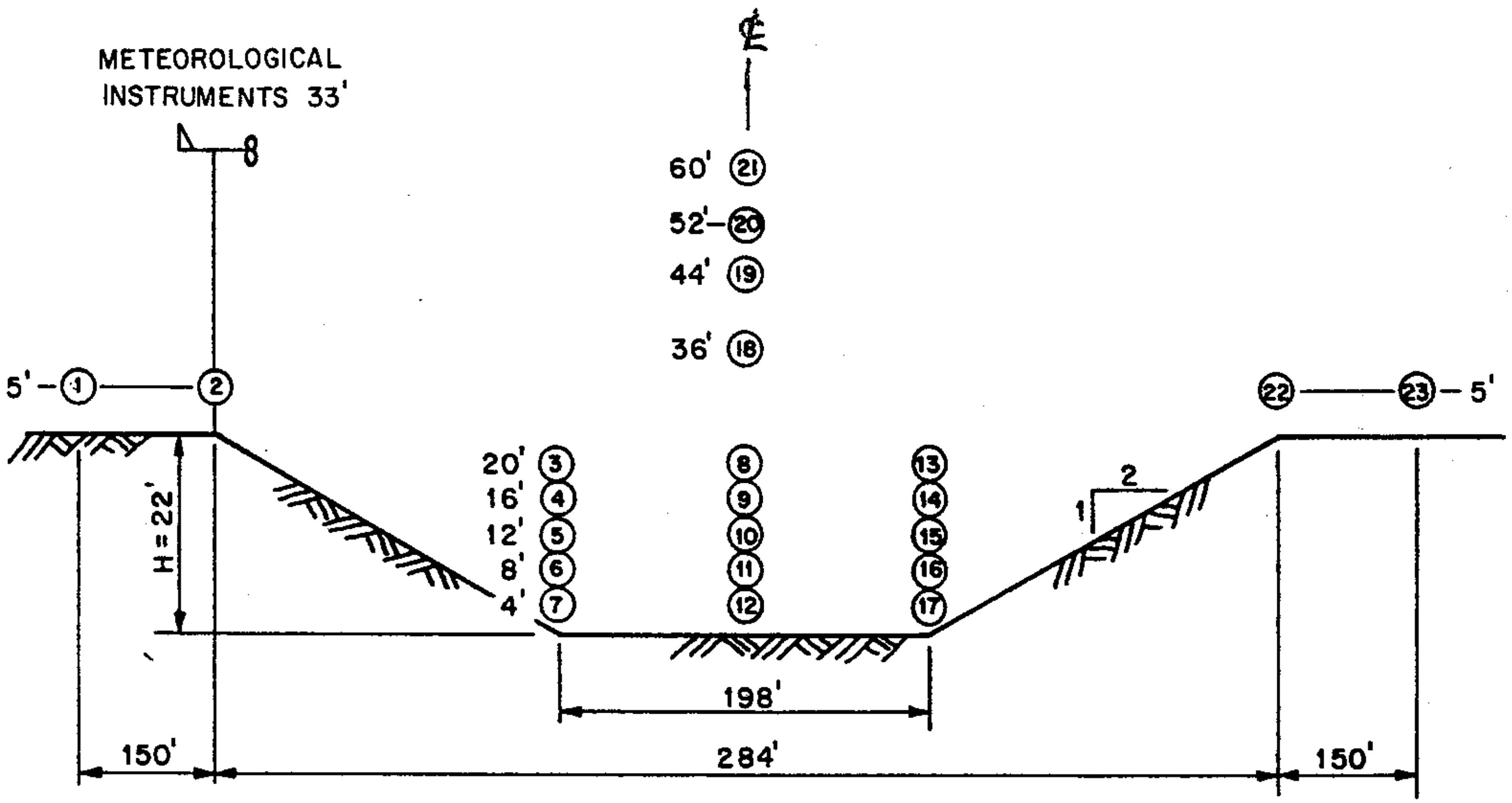


FIG. 20 PROBE LOCATIONS, HARBOR FREEWAY (SITE 2) AT 146TH AVE DOWNWIND STUDY (1972)

(NOT TO SCALE)



1 -DENOTES PROBE NUMBER

FIG. 21 PROBE LOCATIONS, HARBOR FREEWAY (SITE 2) AT 146TH AVE IN-SECTION STUDY (1972)

(NOT TO SCALE)

Figure 22 View of Site 2 From
Freeway Looking North

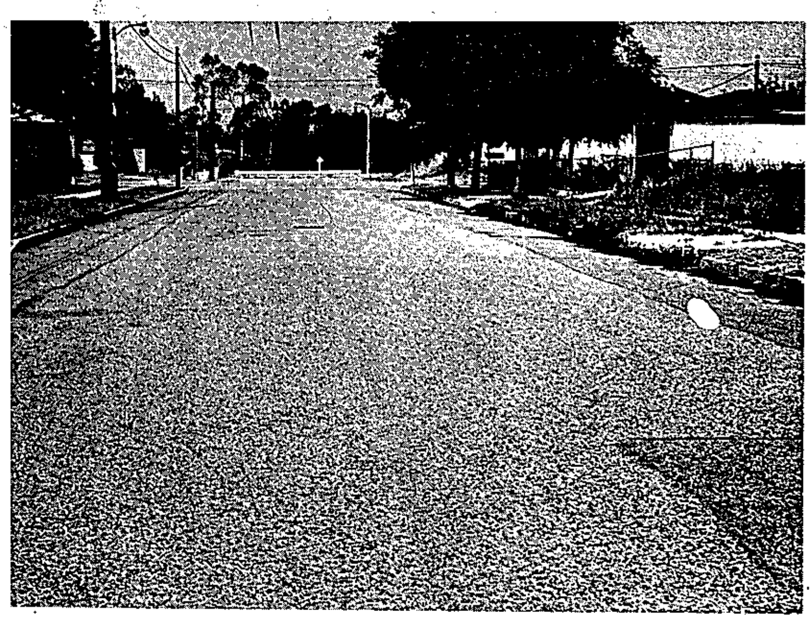


Figure 23 View of Site 2 From
East Side Looking West Toward Freeway

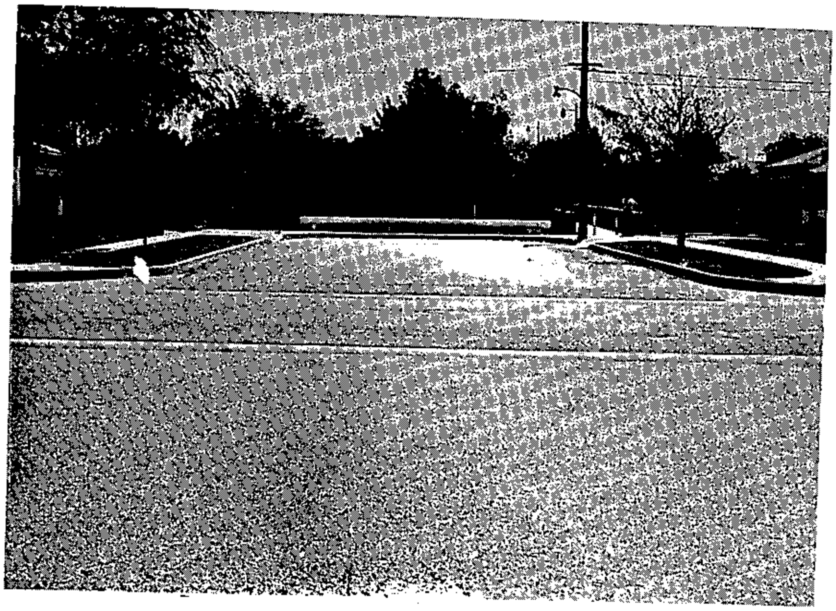


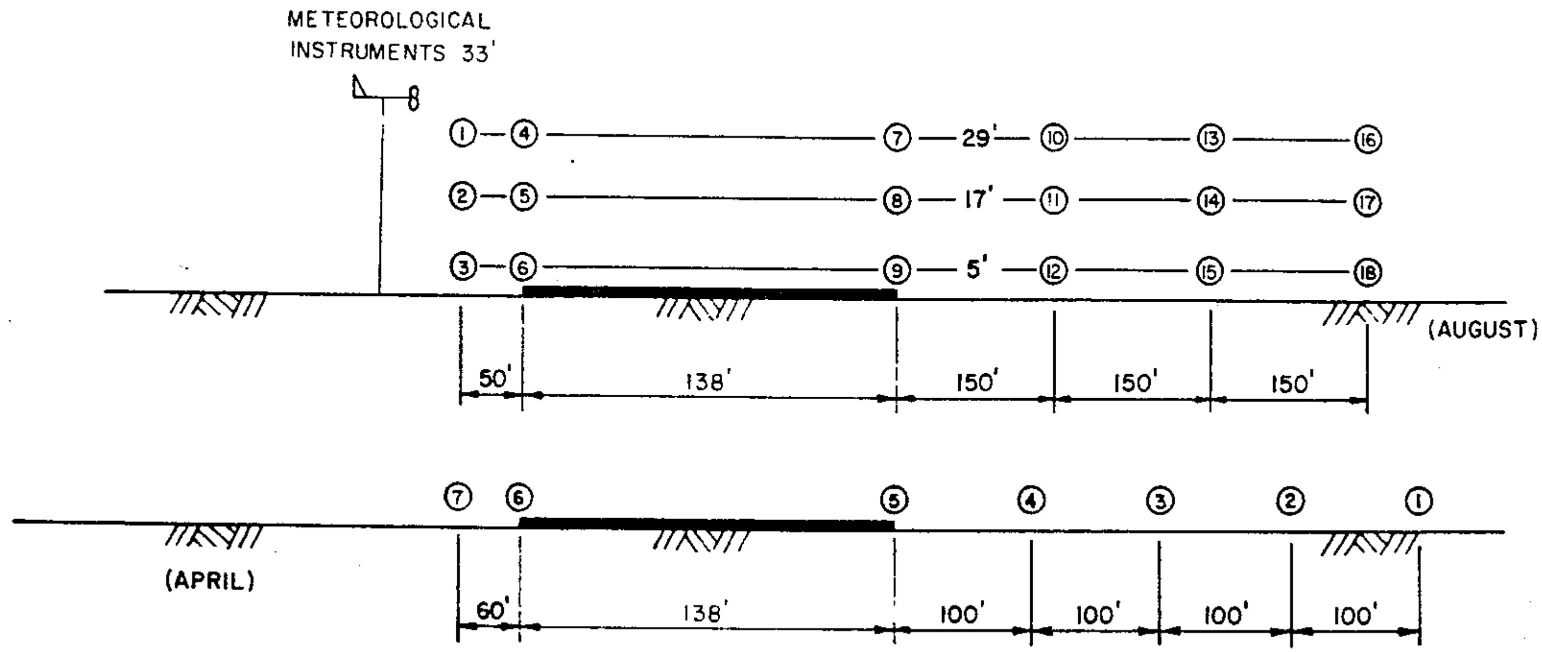
Figure 24 View of Site 2 From the West Side Looking East Toward Freeway

Site 3 - San Diego Freeway at Weigh Station

This site is a typical at-grade 8 lane highway section. It is representative of a highway located in a rural area with a flat, open terrain in both the upwind and downwind directions. The area surrounding the highway consists of an open grassy field on the east side, and a golf course on the west side. The total width of highway from edge of pavement to edge of pavement is 138 feet (42 meters), see Figure 25 for the highway geometrics and probe locations for this site.

There are no other local freeways or surface streets within the immediate area to contribute to the pollutant levels. The site was selected to compare downwind dispersion in an open area with low roughness elements to dispersion in a built-up area with large roughness elements. Study of the surface streamline analysis indicates that prevailing surface winds are generally in a crosswind direction with respect to the highway alignment. Pictures of the site and surrounding area are shown in Figures 26 through 28.

Sites such as this are ideal for model validation because of the simplicity of the terrain. This site is not on the Surveillance Loop Project, however, traffic monitoring pads from which traffic volumes can be obtained are located approximately 1/4-mile (400 m) from the site. The pollutant measurements on the highway are limited to both shoulders of the pavement because there are no support structures located in the median to mount pollutant sensors. The measurement of the horizontal dispersion of pollutants is limited to 400 feet (122 m) from the shoulder in the easterly direction because of a local flood control channel. On the western side of the freeway, the maximum distance from the shoulder is limited to about 60 feet (18.2 m) because of the golf



(1)-DENOTES PROBE NUMBER

FIG. 25 PROBE LOCATIONS, SITE 3, SAN DIEGO FWY.@ WEIGH STATION DOWNWIND STUDY (1972)

(NOT TO SCALE)

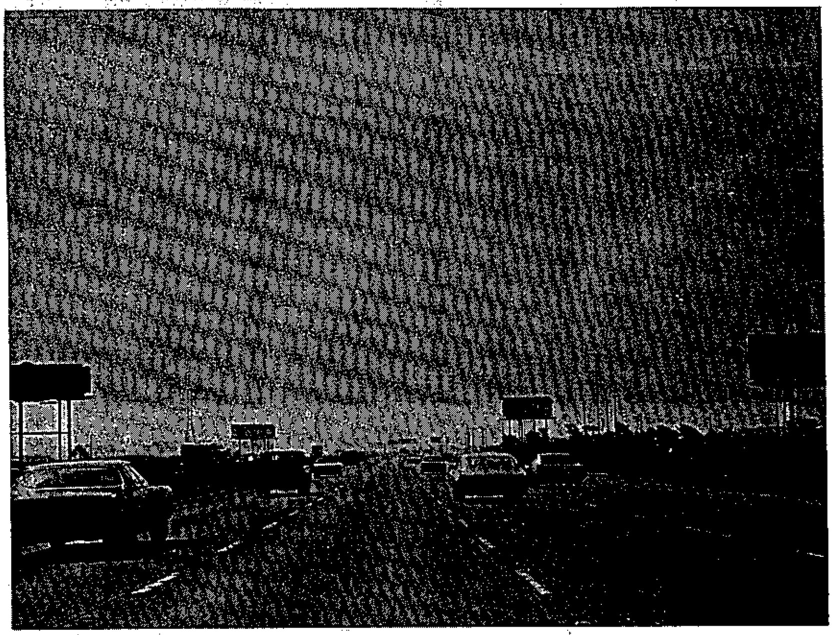


Figure 26 View of Site 3 - San Diego Freeway at Weigh Station as Viewed From Freeway

Figure 27 View of Site 3 From The East Side Looking West Towards Freeway

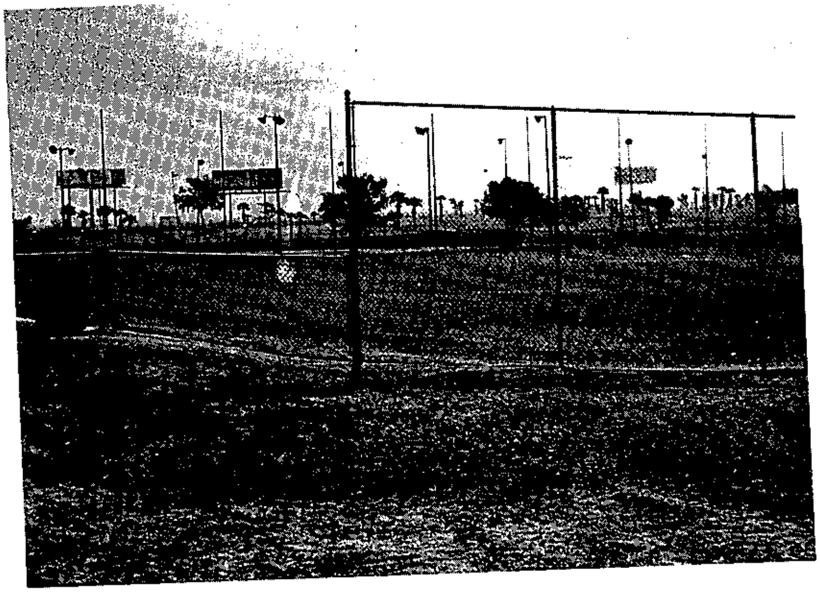


Figure 28 View of Site 3 Looking West Away From Freeway

course facilities. This site can be used only for sea breeze conditions (a wind from the westerly direction).

Site 4 - San Diego Freeway at National Boulevard

This site is typical of an urban at-grade 8 lane freeway with off-ramp. The width of freeway from edge of shoulder to edge of shoulder is 138 feet (42 m) not including the off-ramp. See Figures 29 and 30 for highway geometrics and probe locations for this site. The area surrounding both sides of the site consists of apartment housing for students at the University of California at Los Angeles. They are typical two-story dwellings.

This particular site is also located near a major interchange of the Santa Monica and San Diego Freeways, approximately 1/4-mile (400 m) south of the interchange. The interchange is heavily congested during peak morning and evening traffic hours. There are also two major surface streets running parallel to the highway located about 300 feet (90 m) from both shoulders of the highway. These surface streets are also heavily traveled during the morning and evening traffic hours. Also numerous garages for the apartment dwellings are located about 20 feet (6.1 m) from the edge of the highway on both sides. This site was selected because of the close proximity of receptors to the highway (approximately 50 feet (15.2 m) minimum distance), and the opportunity it offered to study the effects of the major freeway interchange and local streets on pollutant concentrations. From the streamline analyses, the prevailing surface winds are generally in a crosswind direction with respect to the highway alignment. The site is on the Surveillance Loop Project, and there is a road sign crossing the northbound lanes from which probes can be supported to monitor the pollutants on the median and

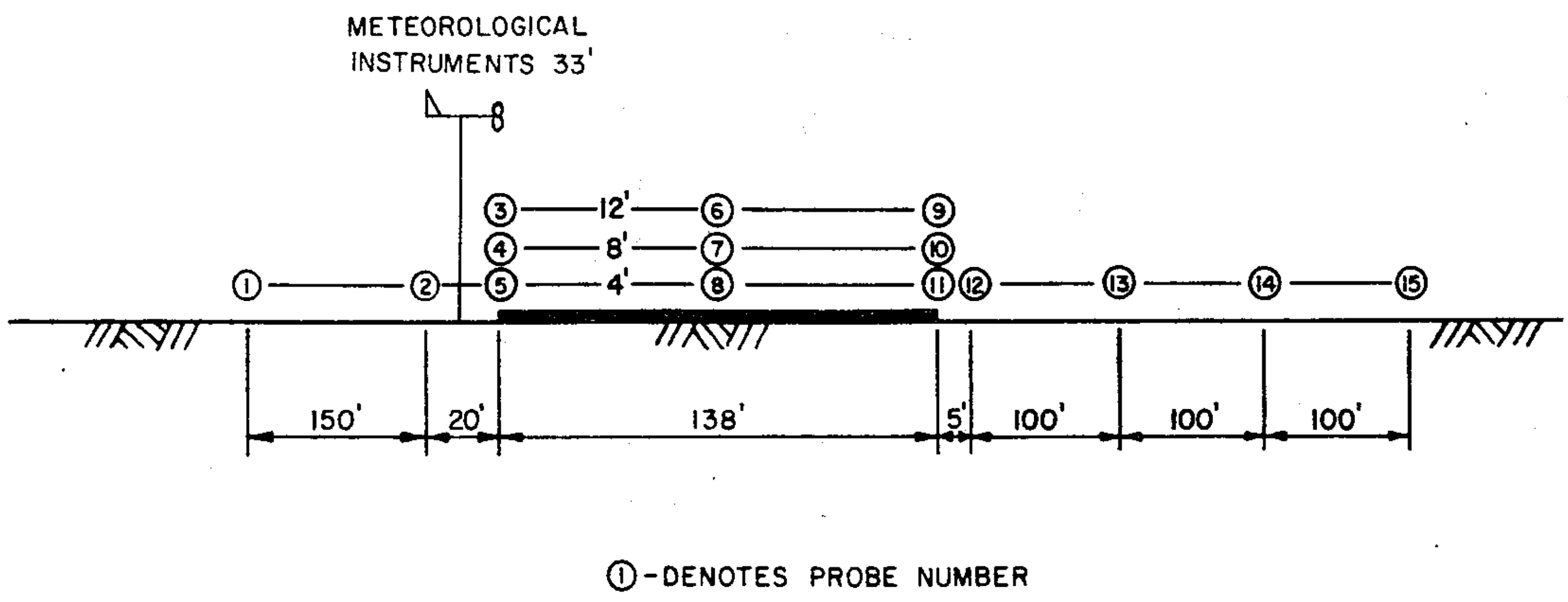


FIG. 29 PROBE LOCATIONS, SITE 4, SAN DIEGO FWY.
@ NATIONAL BLVD, DOWNWIND STUDY (1972)

(NOT TO SCALE)

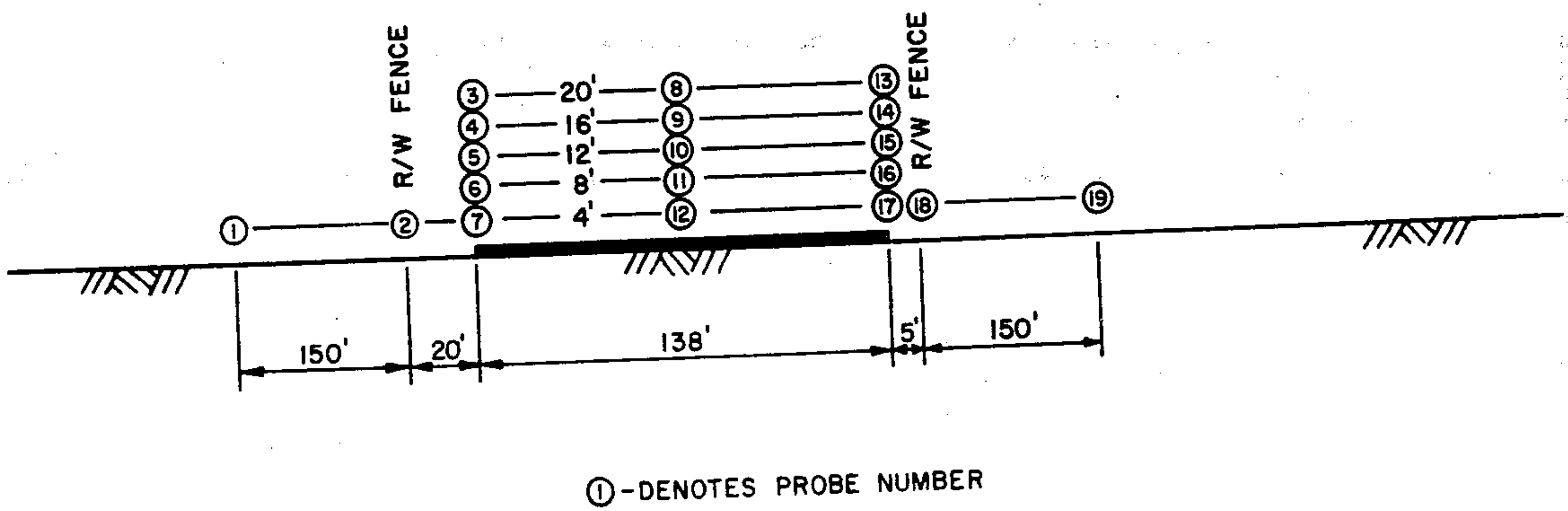


FIG. 30 PROBE LOCATIONS, SITE 4, SAN DIEGO FWY. @ NATIONAL BLVD. IN SECTION STUDY (1972)

(NOT TO SCALE)

the east shoulder of the highway. On the west side, a light standard was used to support the probes. Measurement of the downwind pollutant dispersion is limited to about 300 feet (90 m) before the major surface streets are reached. Pictures of the site and surrounding area are shown in Figures 31 through 33.

Site 5 - San Diego Freeway at 122nd Street

This site is typical of an 8 lane freeway in an urban area on an earth fill section. The height of the fill is 15 feet 4.6 m) above the surrounding terrain. Figure 34 shows the geometrics of the section. The area adjacent to the site is flat and open in both directions. There is a road sign located over the northbound lanes to support probes to monitor the pollutants on the east shoulder and in the median of the highway. On the west side there is a light standard to support a sensor monitoring that side of the highway. There are no other sources of pollutants in the immediate area. The prevailing surface winds are in a crosswind direction with respect to the highway alignment. The site is located on the Surveillance Loop Project.

The major factors in selecting this site are to: evaluate the effect that an elevated source has on the ground level concentrations, evaluate the aerodynamic effects of air flow over a fill on ground level concentrations near the top of the fill (see Figure 35), and compare pollutant dispersion from elevated highways with at grade and depressed sections. Pictures of the site and surrounding area are shown in Figures 36 through 38. The configuration of the sampling probes for the initial bag sampling phase of the study are shown on Figures 39 and 40.

Figure 31 View of Site 4 - San Diego Freeway at National Blvd. as Viewed From Freeway Looking North

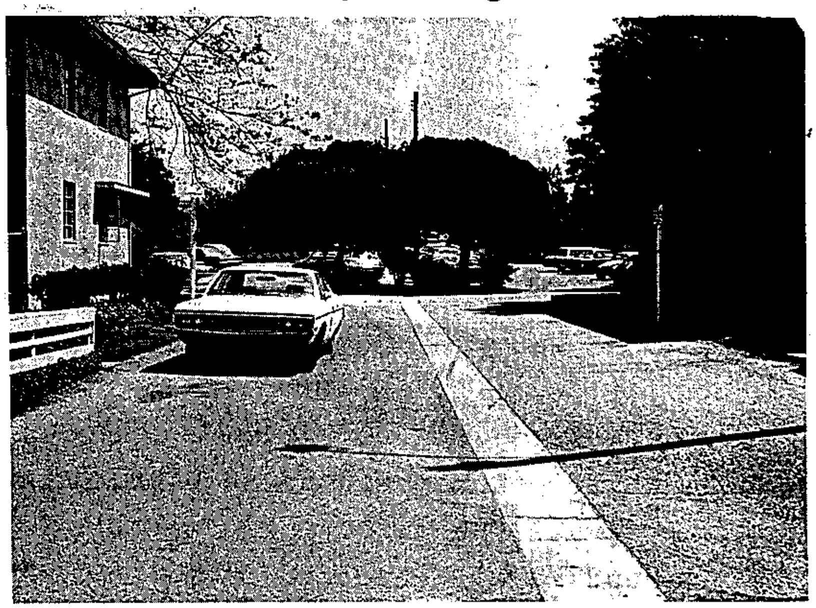


Figure 32 View of Site 4 Looking East Away From Freeway

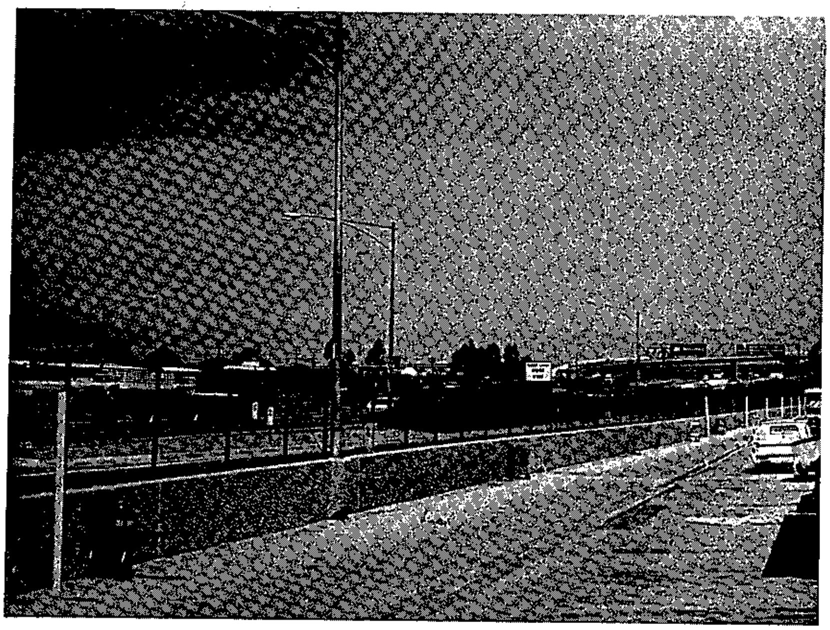


Figure 33 View of Site 4 - East Side Looking West Across Freeway

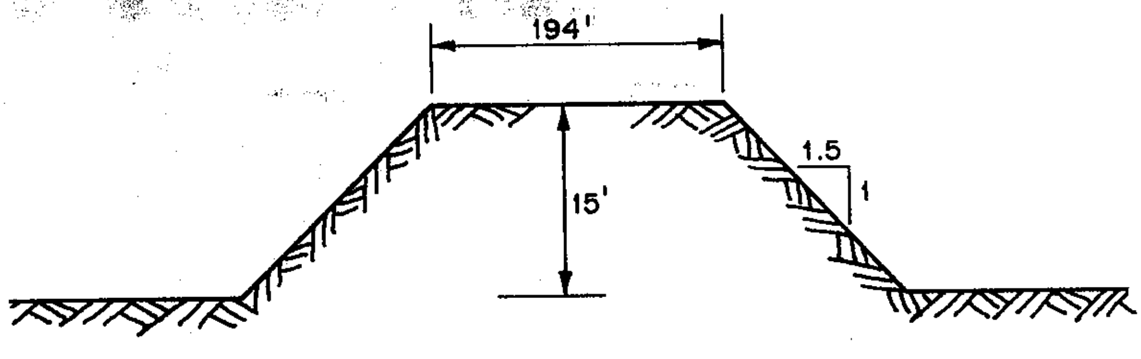


FIG. 34 GEOMETRICS OF SITE 5 --
SAN DIEGO FREEWAY AT 122ND AVE
(NOT TO SCALE)

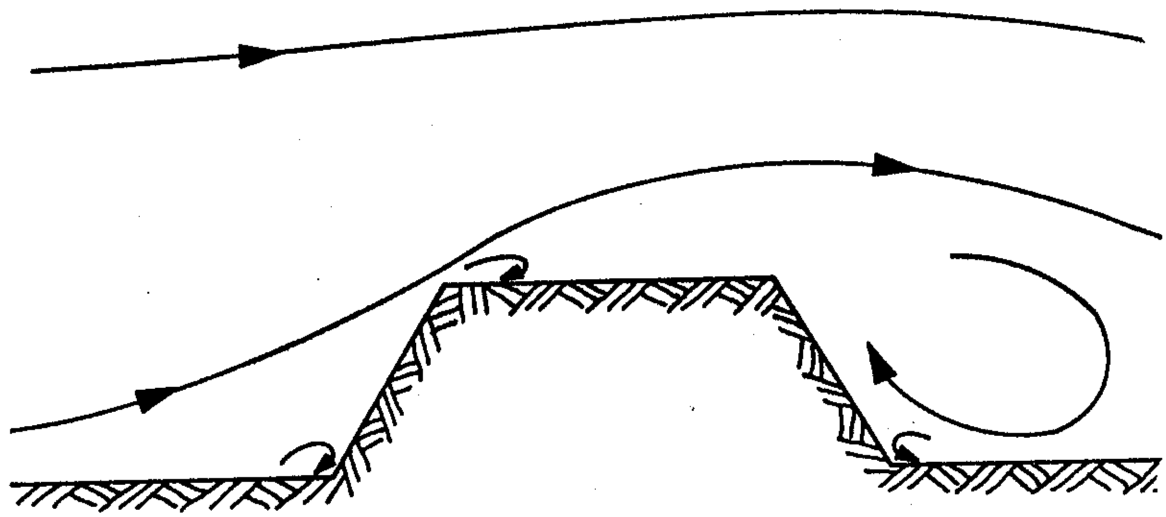


FIG. 35 AERODYNAMIC EDDIES OF AIR FLOW FOR FILL SECTION

Figure 36 View of Site 5 From Freeway Looking North

Figure 37 View of Site 5 - East Side Looking West Towards Freeway

Figure 38 View of Site 5 - West
Side Site Looking East Towards
Freeway

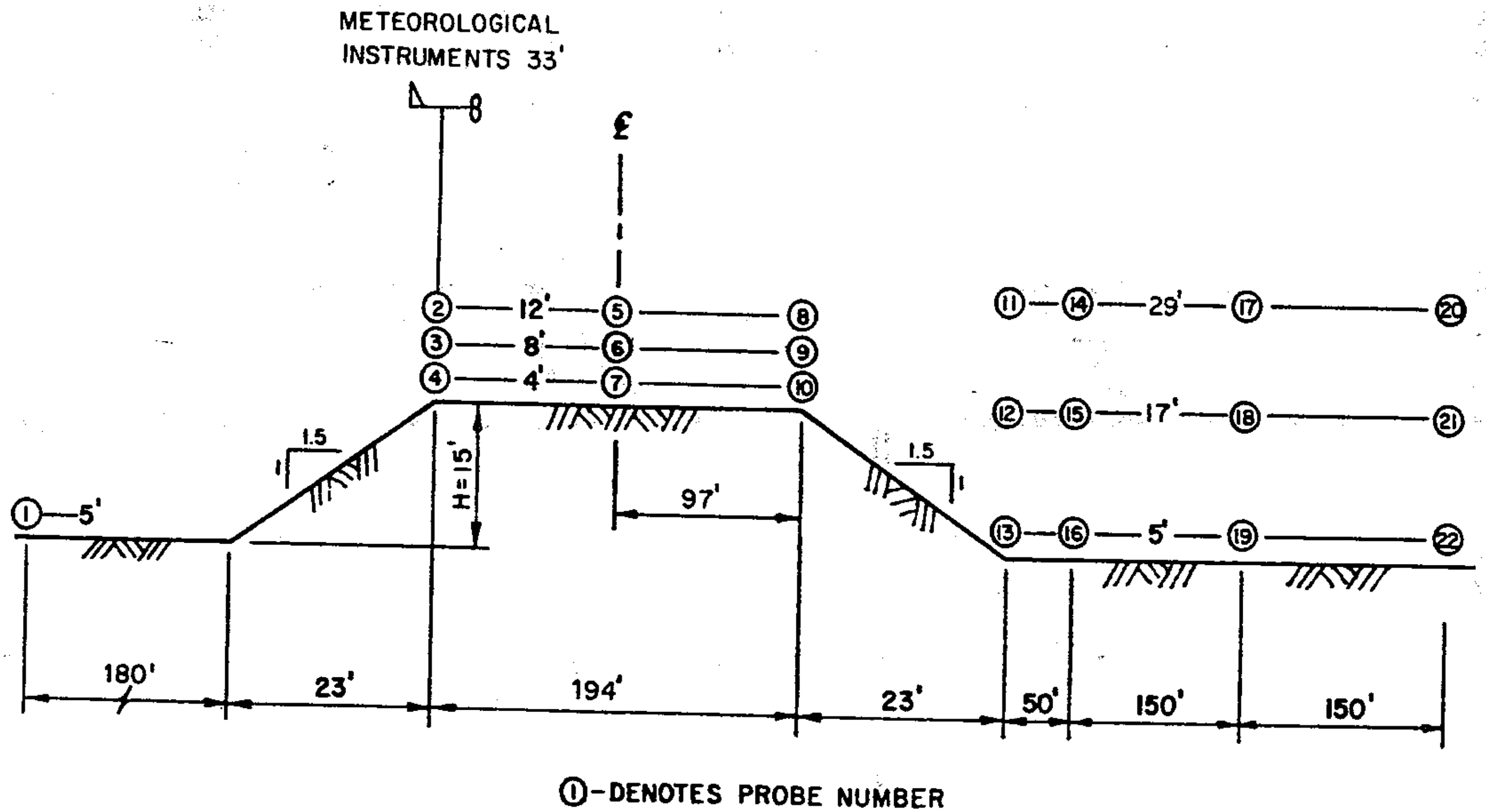


FIG. 39 PROBE LOCATIONS, SITE 5
SAN DIEGO FWY. @ 122ND AVE.
DOWNWIND STUDY (1972)
(NOT TO SCALE)

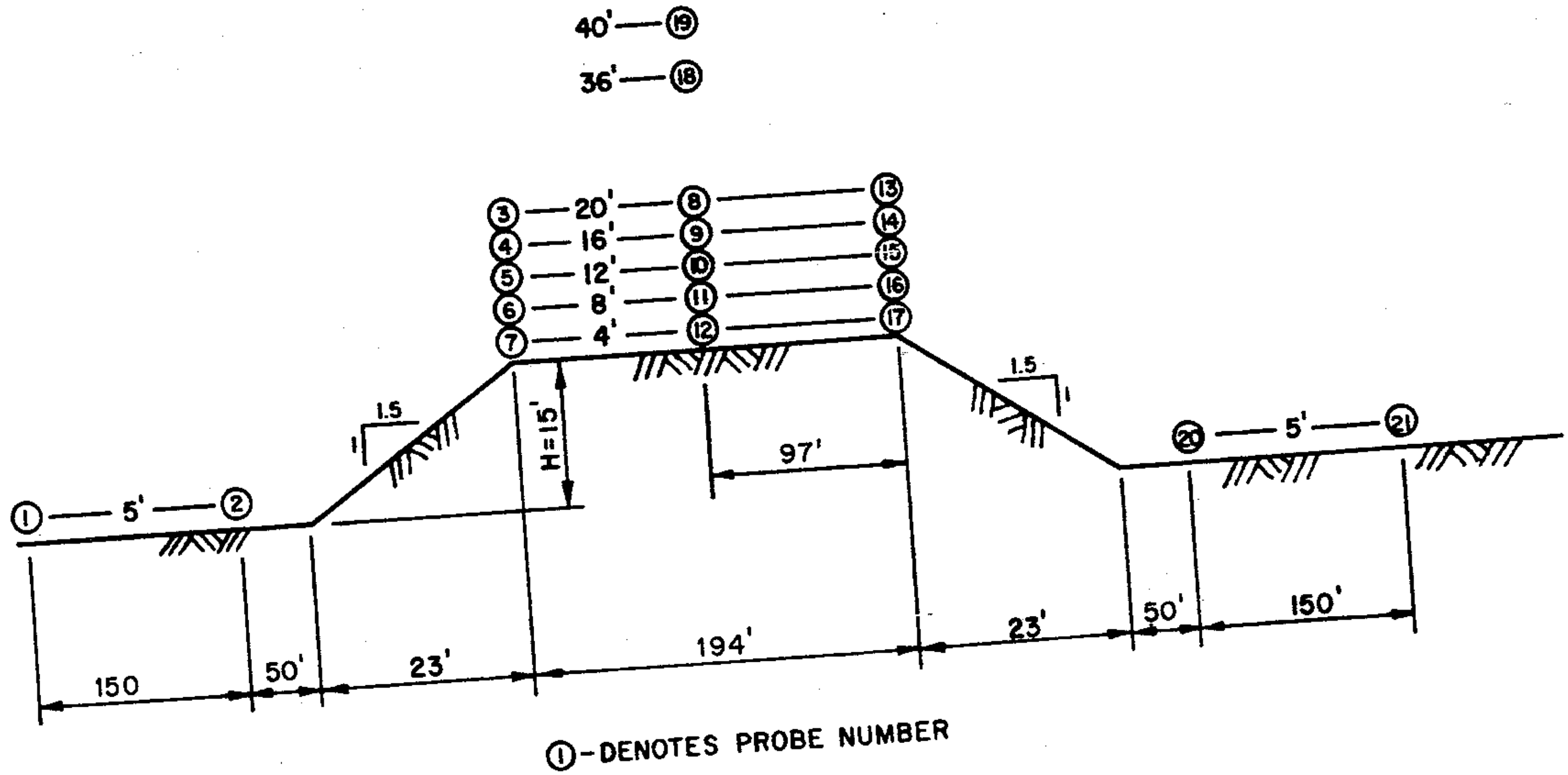
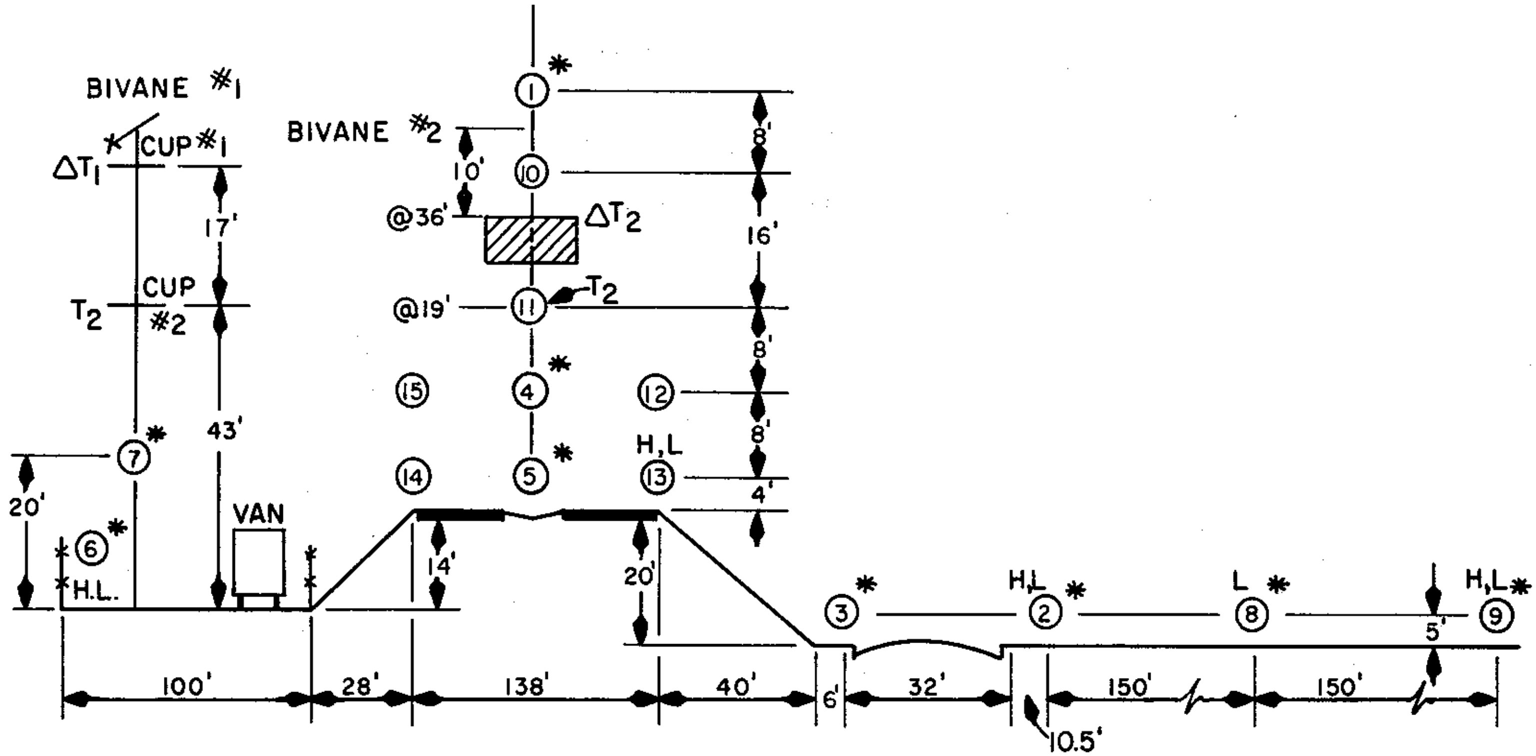


FIG. 40 PROBE LOCATIONS, SITE 5
SAN DIEGO FWY. @ 122ND AVE.
IN SECTION STUDY (1972)
(NOT TO SCALE)

While the mobile research laboratories were under construction, a bag sampling program was performed at Sites 1 through 5, as shown on Figure 2. Refer to Reference 1 for details and preliminary conclusions of that study. Once the first research van was ready, it was located at Site 1. As experience was gained with the mobile research laboratory, it became apparent that Sites 2 through 5 could not be adequately monitored by the mobile laboratory. There was not enough room to locate the mobile laboratory at Sites 2, 3, or 4. At Site 5 there was no way to monitor both sides of the freeway using a single mobile laboratory. Therefore, three alternate sites were chosen.

Site 6 is the San Diego Freeway at 134th Street, only 12 blocks from the originally chosen 122nd Street site. Site 6 is very similar to Site 5, but it also has a drainage conduit crossing under the highway. See Figures 41 and 42 for highway geometrics. The conduit was used to pass the pollutant probes from the west side of the freeway to the east side. It was also used to pass both the pollutant probes and the electrical cables from the meterological sensors at the median to the mobile laboratory. See Figures 43 through 45 for pictures of the site.

Site 7 was included to study the pollutant levels adjacent to a frequently used on-ramp and to compare a heavily traveled surface street to a nearby freeway. The on-ramp is adjacent to a signalized intersection. These streets experience congestion during the morning hours. Refer to Figure 46 for the geometrics of the site. Figures 47 through 50 show the area surrounding Site 7.



LEGEND

3 = PROBE NUMBER
* = PROBE FOR BAG BOX
L = LUNDGREN IMPACTOR
H = HI VOL SAMPLER

FIG.41 PROBE LOCATIONS, SITE 6, SAN DIEGO FWY. AT 134TH STREET (1974-75)

(NOT TO SCALE)

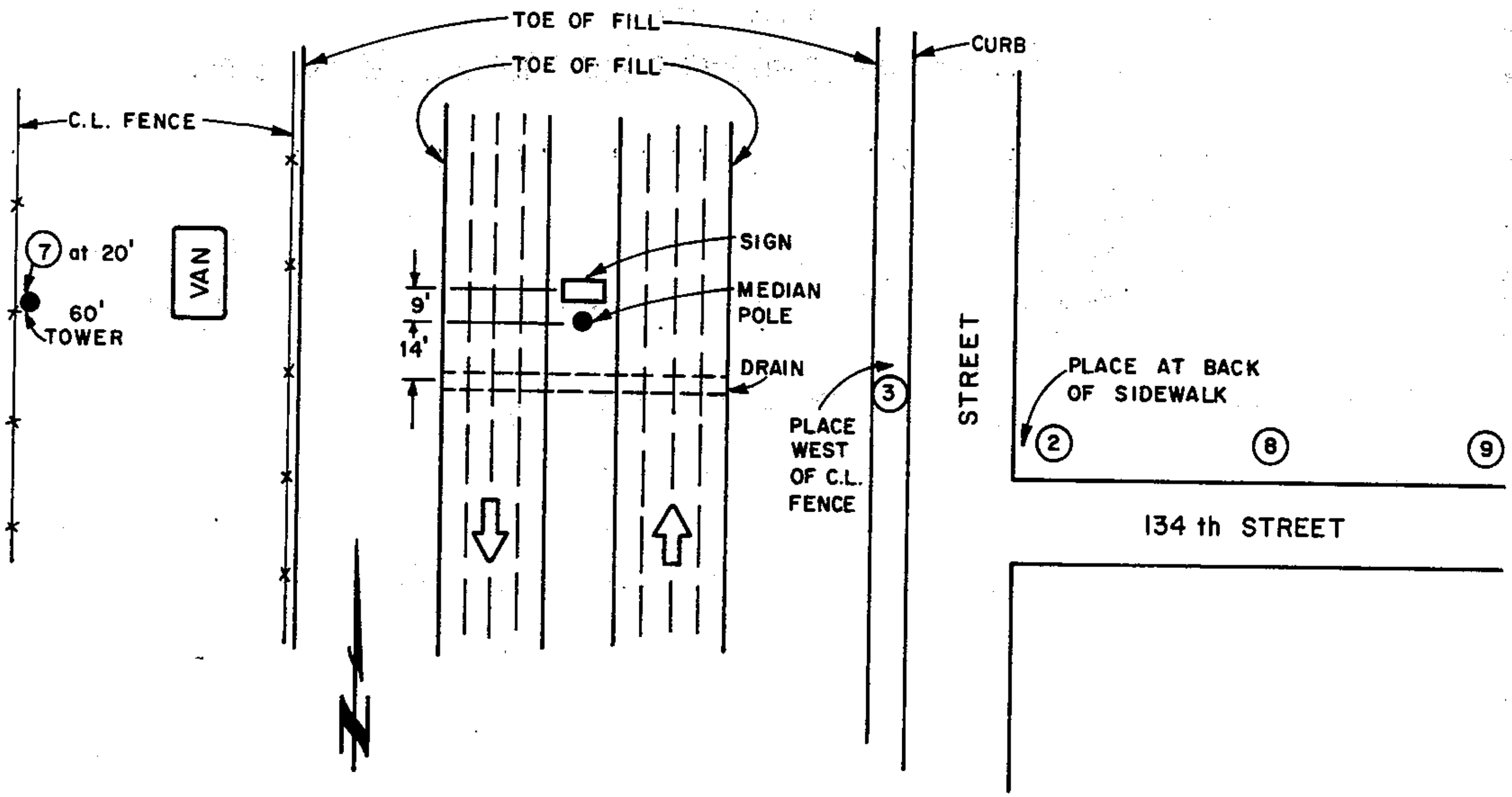


FIG. 42 PLAN VIEW, SITE 6, SAN DIEGO FWY.
AT 134TH STREET (1974-75)

(NOT TO SCALE)

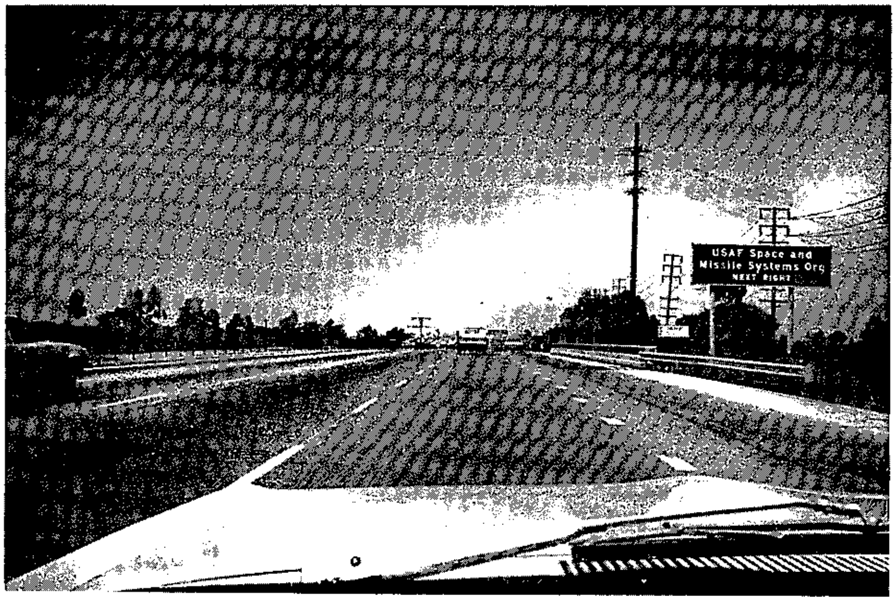


Figure 43 View of Site 6
From Freeway Looking
North

QUALITY CONTROL

In an automated data collection system, quality control procedures are necessary to insure that reliable data is being collected. The field personnel who operate the mobile laboratories examine all the strip charts on an hourly basis. They check for rapid deviations in the parameters measured. They also check to see if the values fall within a reasonable range (see Table 7).

As can be seen from Figure 86, the strip charts do not check the voltage side of the data acquisition system. To check this, a cathode ray tube is used. This will determine whether the system is operating properly from the signal conditioning unit up to entrance into the minicomputer. Ranges of values can also be observed on a cathode ray tube.

Periodically, the field personnel observe the meter indications of the air quality instrumentation in the bag box system, along with wind speed, wind direction, and temperature lapse rate. These observations are compared to strip chart values, values summarized on the minicomputer, and later to values on the SAROAD data system master file.

At the end of the sampling day, the daily magnetic tape is analyzed by the minicomputer. Hourly averages of 0700-0800, 1200-1300 and 1700-1800 hours are obtained. These hourly averages are also checked for range of values. The standard error is examined in order to evaluate reasonableness of the variability.

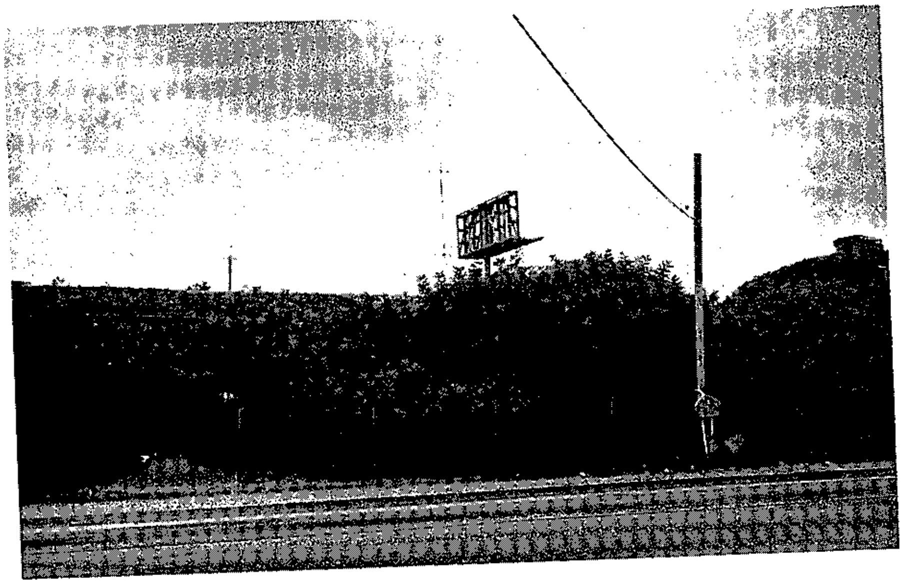


Figure 45 View of Site 6
Looking West Across The
Frontage Road At Freeway
Embankment

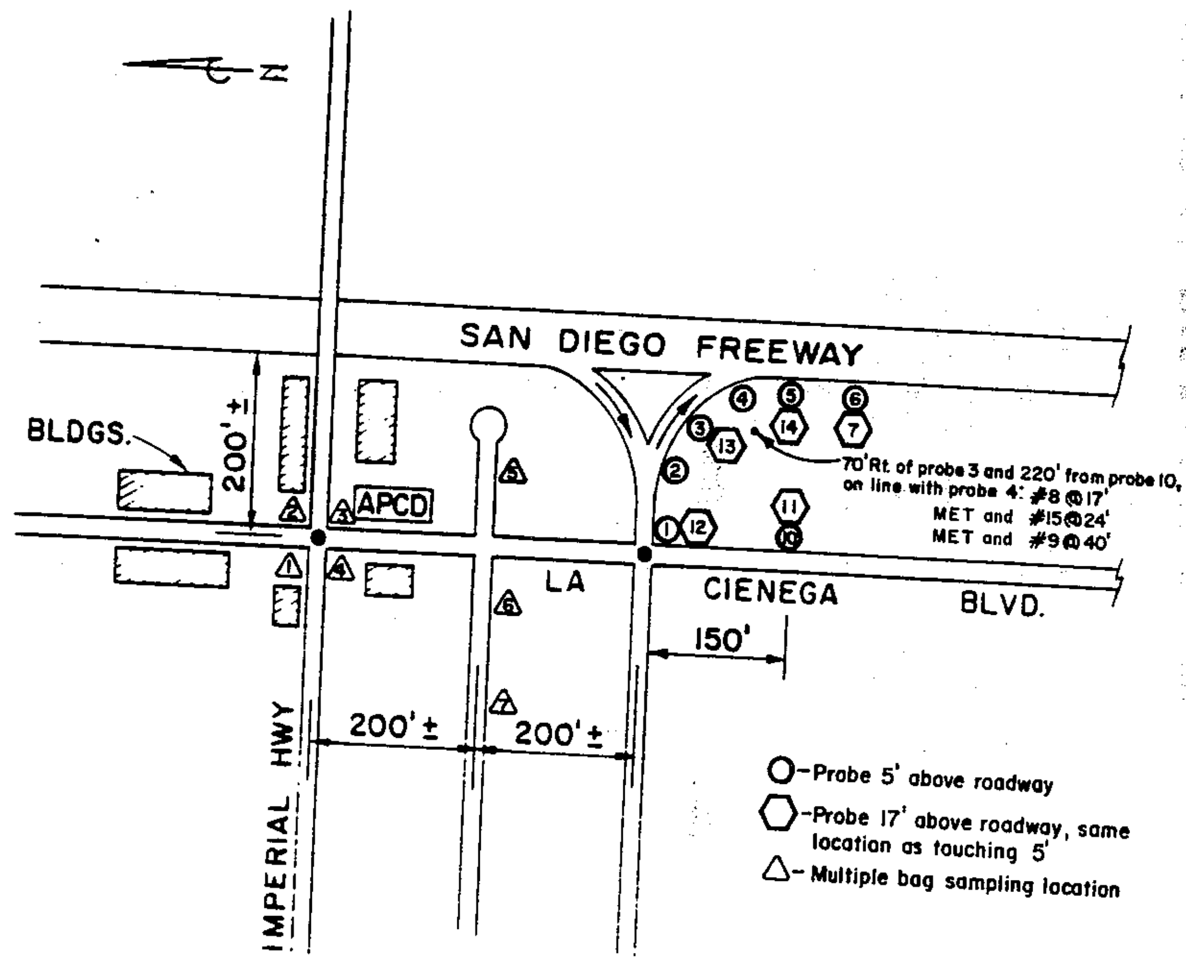


FIG. 46 PROBE LOCATIONS, SITE 7
SAN DIEGO FWY. AT IMPERIAL
HIGHWAY (1975)

(NOT TO SCALE)

Figure 47 View of Research Van Location at Site 7

Figure 48 View of On-Ramp and Probe Location at Site 7

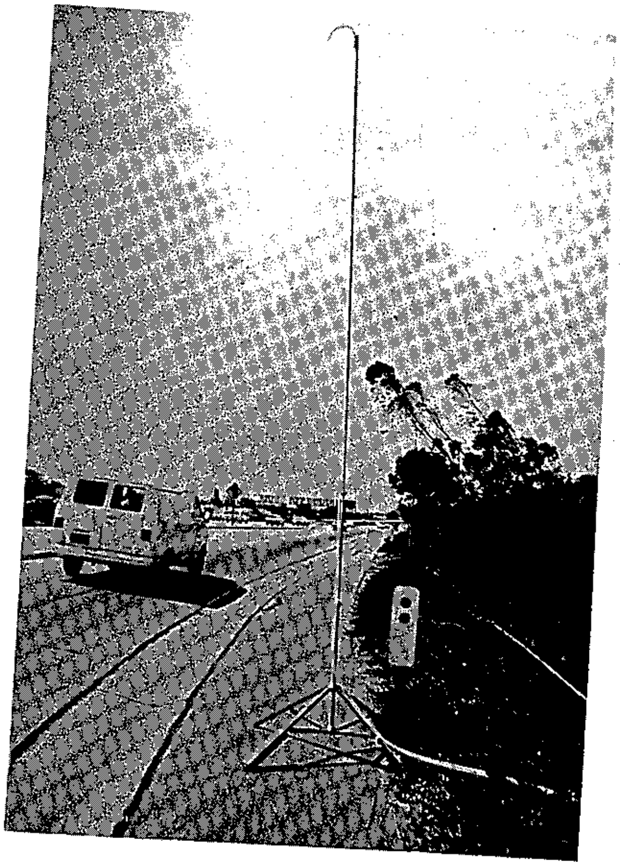


Figure 49 View of On-Ramp Merge Zone and Probe Location at Site 7

Figure 50 View of Site 7 Looking North Along La Cienega Boulevard

Site 8 replaces Sites 3 and 4. It is an at-grade site in an open area with prevailing crosswinds. This site is on the Santa Ana Freeway near the El Toro Marine Air Base. Traffic counts are available from nearby traffic sensors. Geometrics of the highway are shown in Figure 51.

Table 4 gives the general summary of all the sites used in this study.

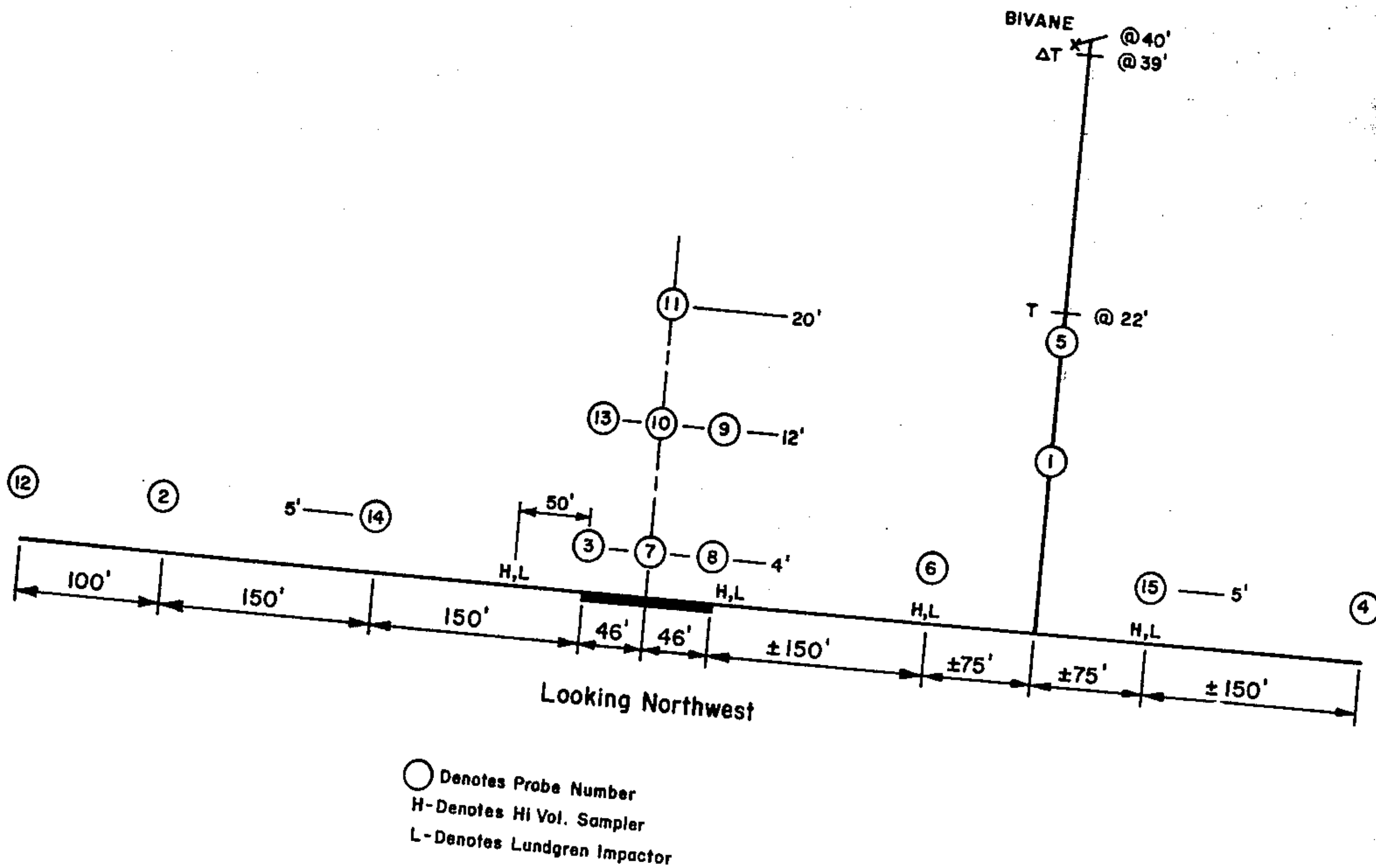


FIG. 51 PROBE LOCATIONS, SITE 8, SANTA ANA FREEWAY
ORANGE COUNTY RACEWAY SOUTH OVERCROSSING (1975)

(NOT TO SCALE)

TABLE 4

SUMMARY OF SITES SELECTED FOR FIELD MONITORING

Site No.	Site Location	Wind Pattern	Background Interference	Type of Highway Design	Monitoring Feasibility	Miscellaneous
1	Santa Monica Freeway at 4th Avenue Pedestrian Overcrossing (Interstate 10)*	Prevailing winds generally parallel to freeway	Minor site is located on a cul-de-sac in mixed one- and two-story residential area	Cut	Pedestrian overcrossing & city streets provide excellent monitoring capabilities	Site located on the Surveillance Project Loop
2	Harbor Freeway at 146th Avenue Pedestrian Overcrossing (California Route 11)	Prevailing winds are generally normal to freeway	Minor site is located on a cul-de-dac in single story residential area	Cut	Pedestrian overcrossing & city streets provide excellent monitoring capabilities	Site located on the Surveillance Loop Project
3	San Diego Freeway at Weigh Station (Interstate 405)	Prevailing winds are generally in a crosswind direction	No background interference. Site is located in flat open open area (semi-rural)	At Grade	Excellent monitoring capabilities except the median of freeway is not accessible for monitoring	Site is not located on Surveillance Loop Project. However, traffic census pads are located in immediate area for traffic data
4	San Diego Freeway at National Blvd. (Interstate 405)	Prevailing winds are generally normal to freeway	Background interference may be a problem. However, this site is representative of CO levels of receptor near major highway interchanges and parallel surface streets.	At grade	Excellent monitoring capabilities on freeway; however, limited in horizontal direction to about 300 feet from highway.	Site is located on Surveillance Loop Project.
5	San Diego Freeway at 122nd Street (Interstate 405)	Prevailing winds are generally normal to freeway.	No background interference. Site is located in a flat open area.	Earth-fill	Excellent monitoring capabilities on the freeway and horizontally.	Site is located on Surveillance Loop Project
6	San Diego Freeway 134th Street (Interstate 405)*	Prevailing winds are generally normal to freeway alignment	Minor interference from adjacent surface streets	Earth-fill	Excellent, except not good for land breeze.	Site is located on Surveillance Loop Project.
7	San Diego Freeway at Imperial Highway (Interstate 405)*	Prevailing winds are generally normal to freeway alignment	Two heavily travelled surface streets	On-ramp to fill	Good on west side only	Near Lennox APCD Station.
8	Santa Ana Freeway (Interstate 5)*	Prevailing winds are generally normal to freeway alignment	None	At grade	Excellent both sides.	Not on Surveillance Loop. However traffic data are available.

*Indicates site for Mobile Research Laboratory

FIELD BAG SAMPLING STUDY FOR CARBON MONOXIDE

In order to obtain a preliminary knowledge of the distribution of pollutants adjacent to heavily traveled freeways, a bag sampling study of carbon monoxide was undertaken. Information from this study led to optimizing the probe configurations for the various sites. Preliminary evaluation of the California Line Source Model (CALINE) was also performed using the bag data. Probe configurations for the various sites are detailed in Figures 10, 11, 20, 21, 25, 29, 30, 39, and 40.

Typical carbon monoxide concentrations for Sites 1, 2, 3, and 5 are depicted in Figures 52 through 55 for each site. Figure 56 indicates the carbon monoxide distribution adjacent to Site 5 during an air pollution episode.

Refer to Reference 1 for more details of the bag sampling study.

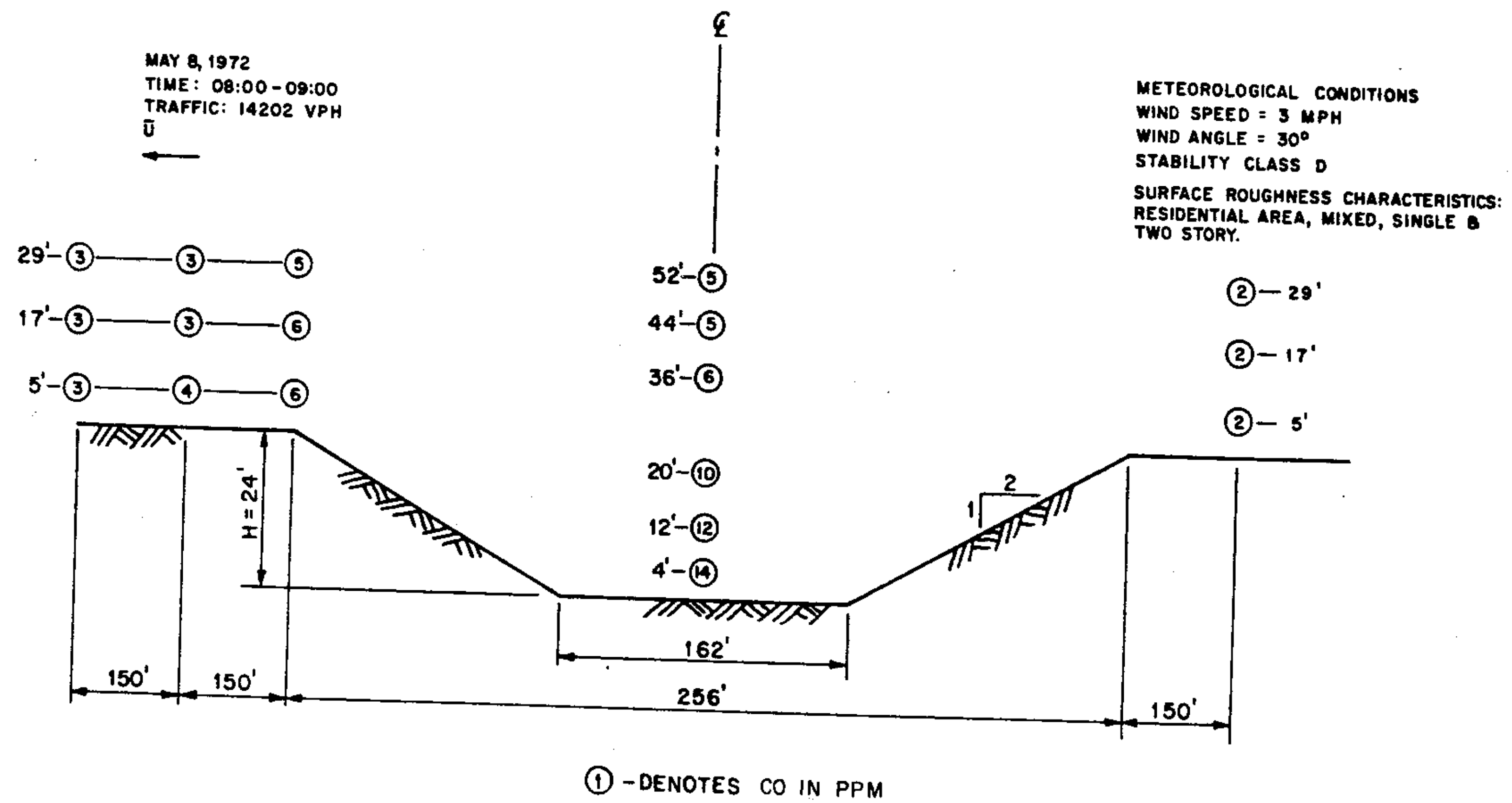


FIG. 52 SPATIAL DISTRIBUTION OF CO AT 4TH AVE. P.O.C. (SITE I)
(NOT TO SCALE)

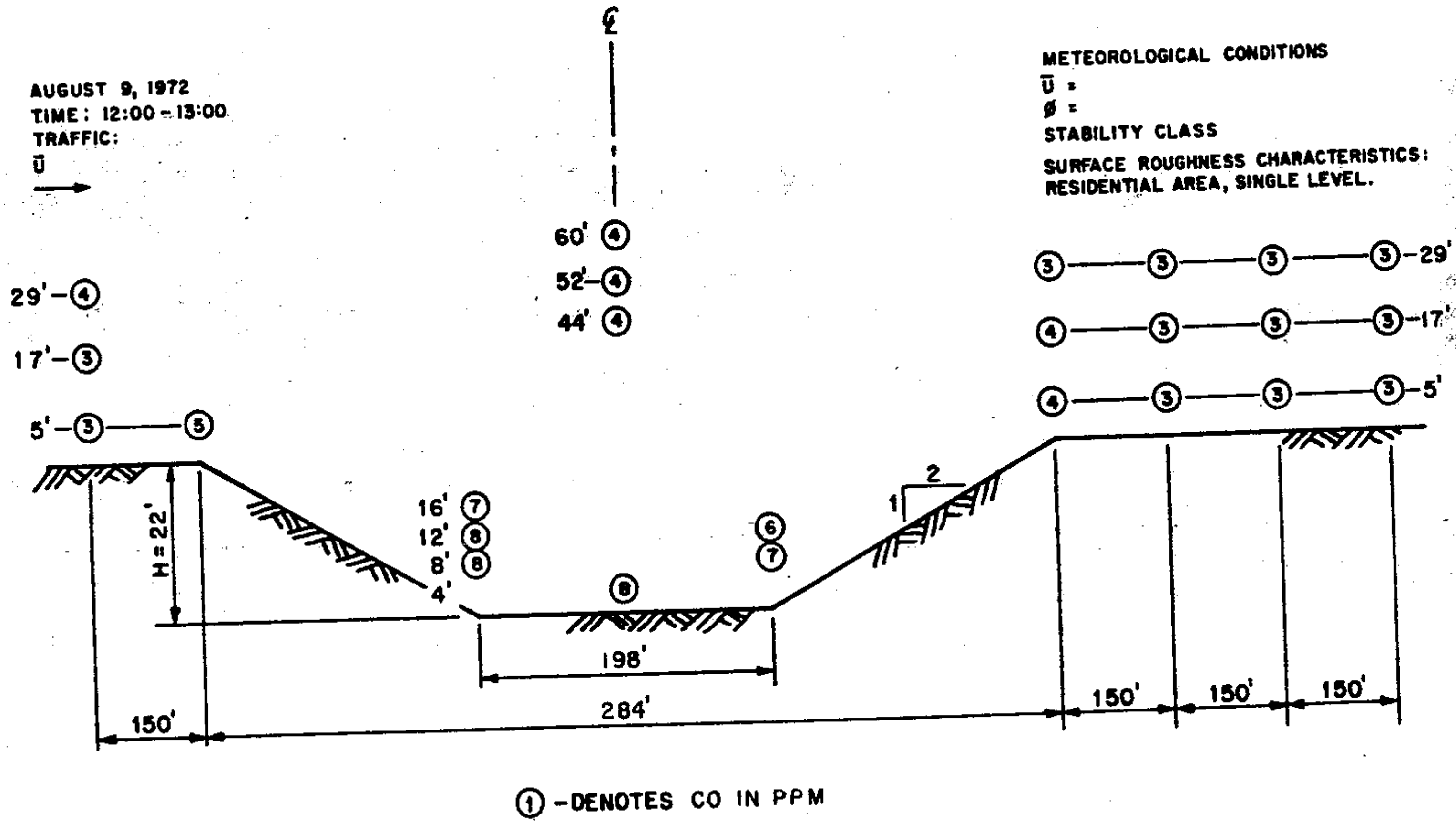


FIG. 53 SPATIAL DISTRIBUTION OF CO AT 146TH AVE. P.O.C. (SITE 2)

(NOT TO SCALE)

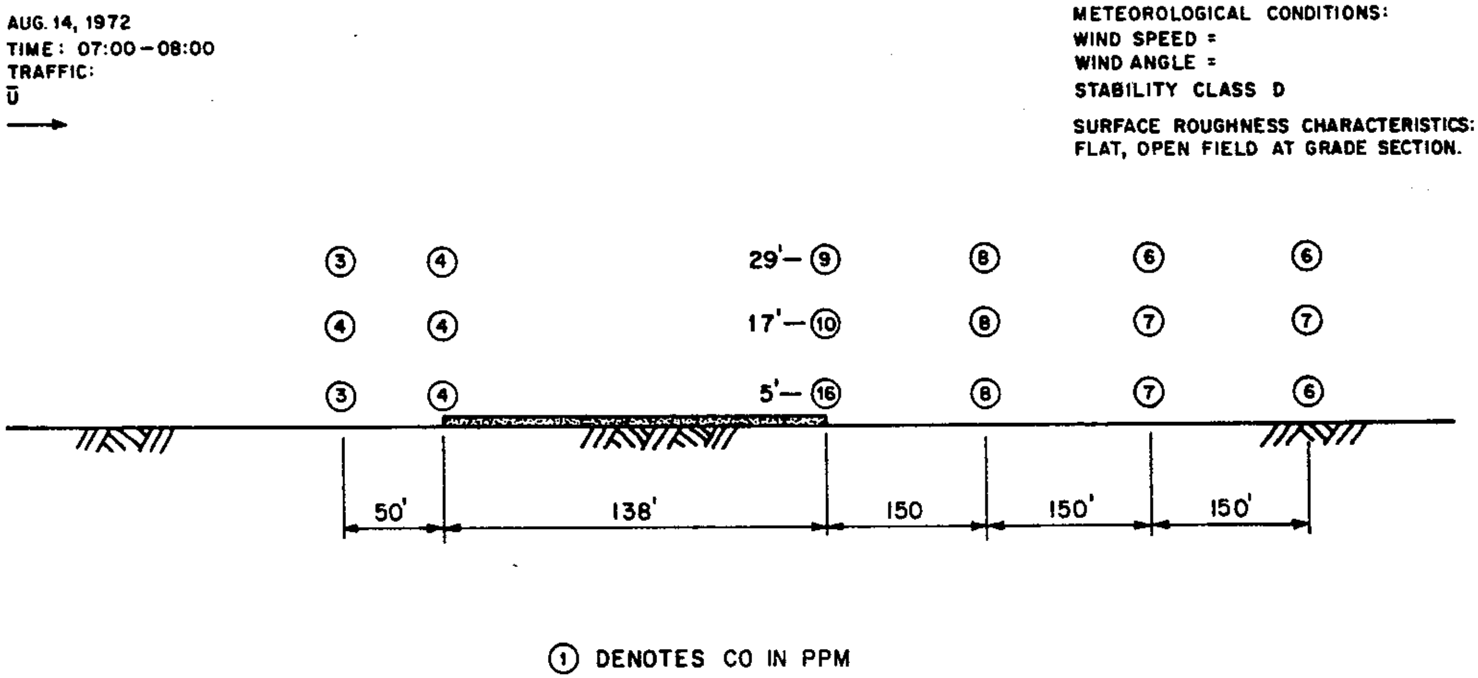


FIG. 54 SPATIAL DISTRIBUTION OF CO AT WEIGH STATION (SITE 3)
(NOT TO SCALE)

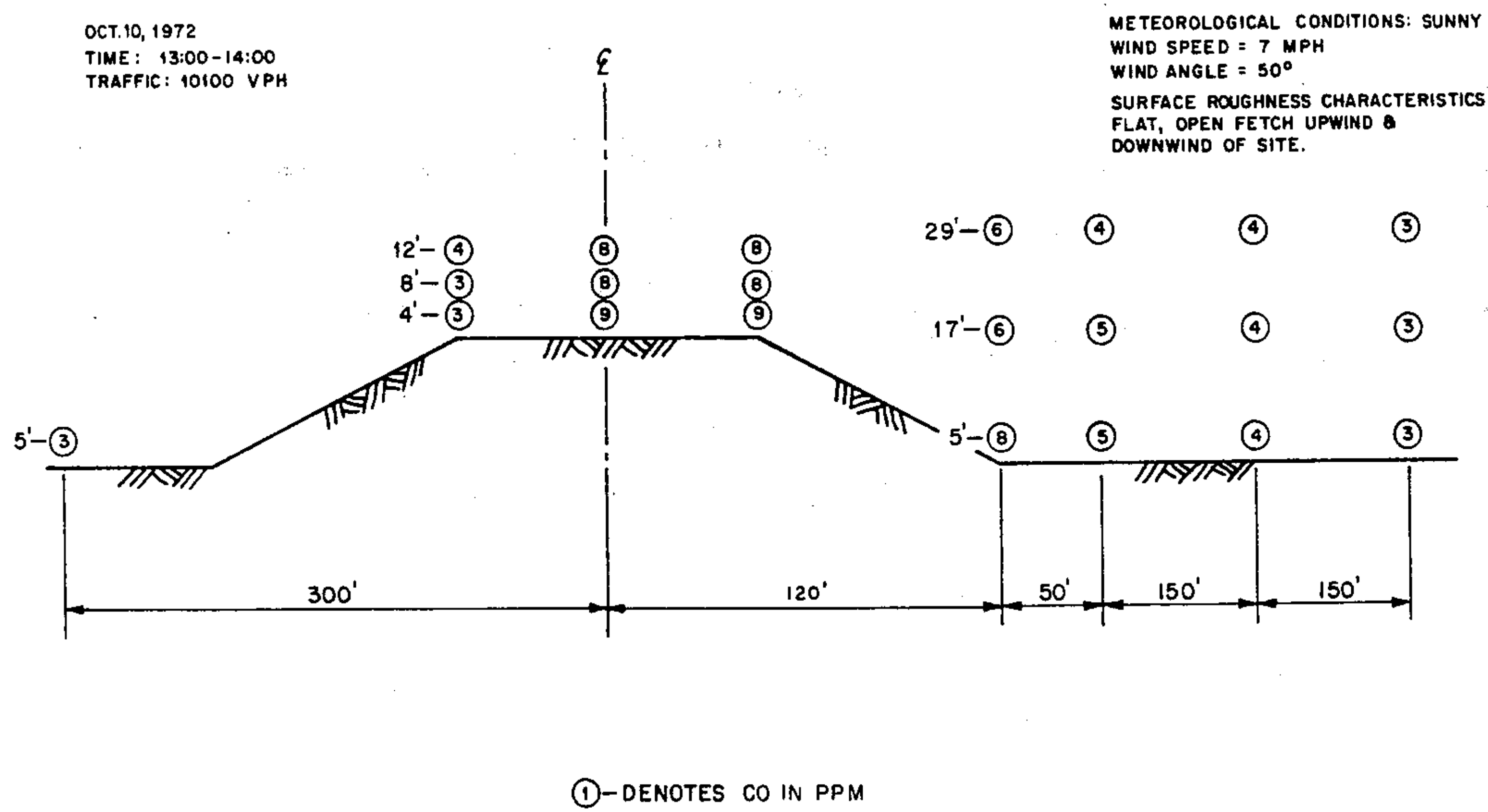


FIG. 55 SPATIAL DISTRIBUTION OF CO AT 122ND AVE (SITE 5)
(NOT TO SCALE)

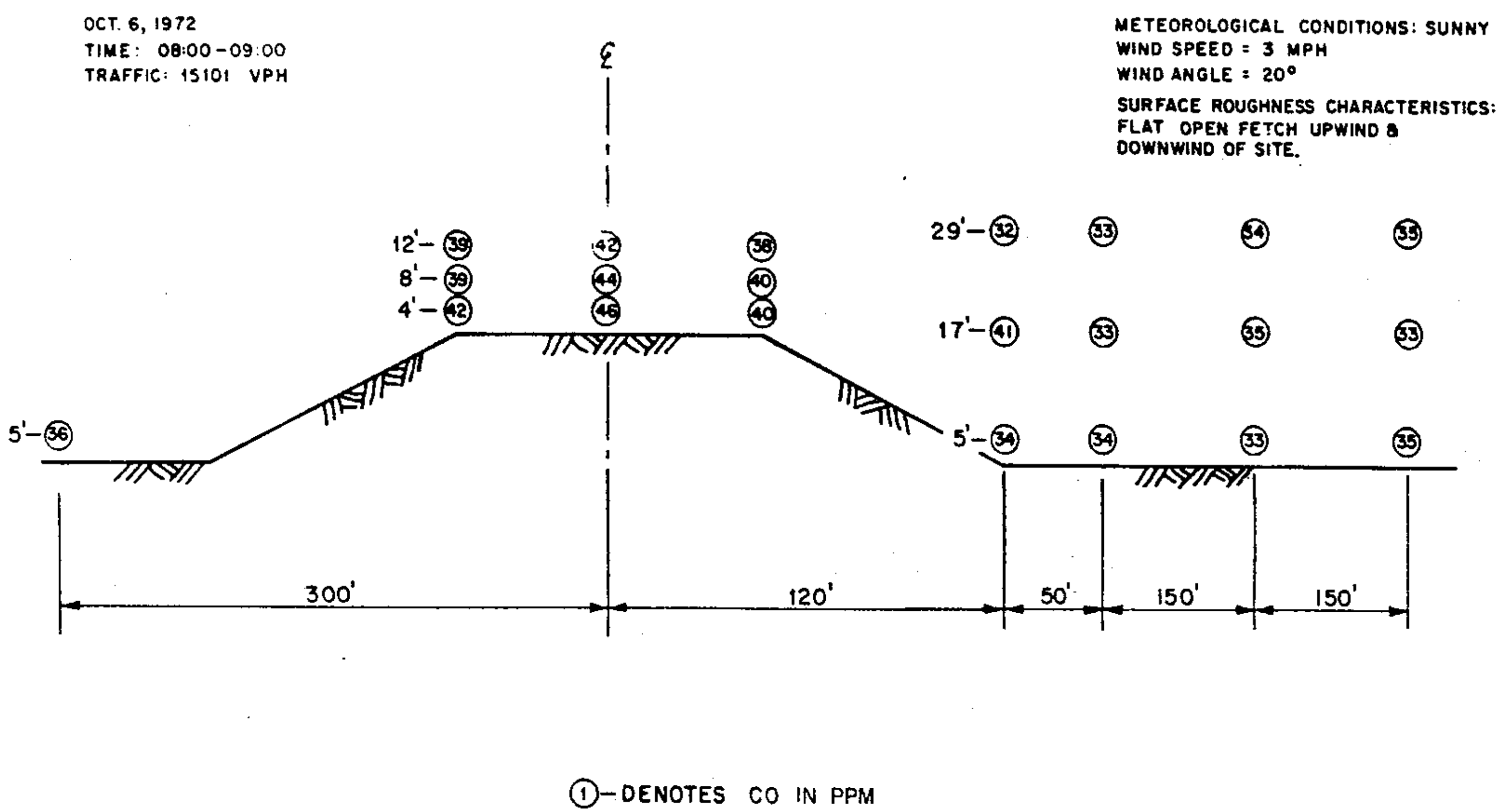


FIG. 56 CO AIR POLLUTION EPISODE (SITE 5)
SAN DIEGO FREEWAY AT 122ND AVE
(NOT TO SCALE)

CALIFORNIA LINE SOURCE MODELING DEVELOPMENT AND EVALUATION

A line source model (CALINE 1) was developed by Caltrans for the purpose of evaluating microscale air quality impact. References 2a through 2f provide a detailed description of the line source model and various support activities which can be used in concert to provide air quality impact estimates.

The California Line Source model is a combination box and Gaussian diffusion model. Initial pollutant dispersion is achieved through the mechanical turbulence of the vehicles on the roadway. Pollutant dispersion in the downwind direction is achieved through atmospheric turbulence, characterized by a Gaussian distribution of pollutant concentrations. Figure 57 illustrates the model for crosswind conditions and an at-grade source.

As data became available from the carbon monoxide bag sampling phase of this study, it became apparent that the model generally over-predicted.

An attempt was made to improve the model for depressed freeway sections, using empirically derived curves for the vertical dispersion rate of CO.

From the data gathered during the bag sampling study, a mathematical relationship using regression techniques relating height above pavement to carbon monoxide concentrations as a function of surface stabilities was derived. The relationship was derived from heights above the pavement of 4 feet to 44 feet (1.2 m to 13.4 m) and applies <u>only</u> to depressed sections. These CO concentrations were measured in the median on the Santa Monica Freeway at the 4th Avenue Pedestrian Overcrossing (Site 1) and on the Harbor Freeway at the 146th Avenue Pedestrian Overcrossing (Site 2).

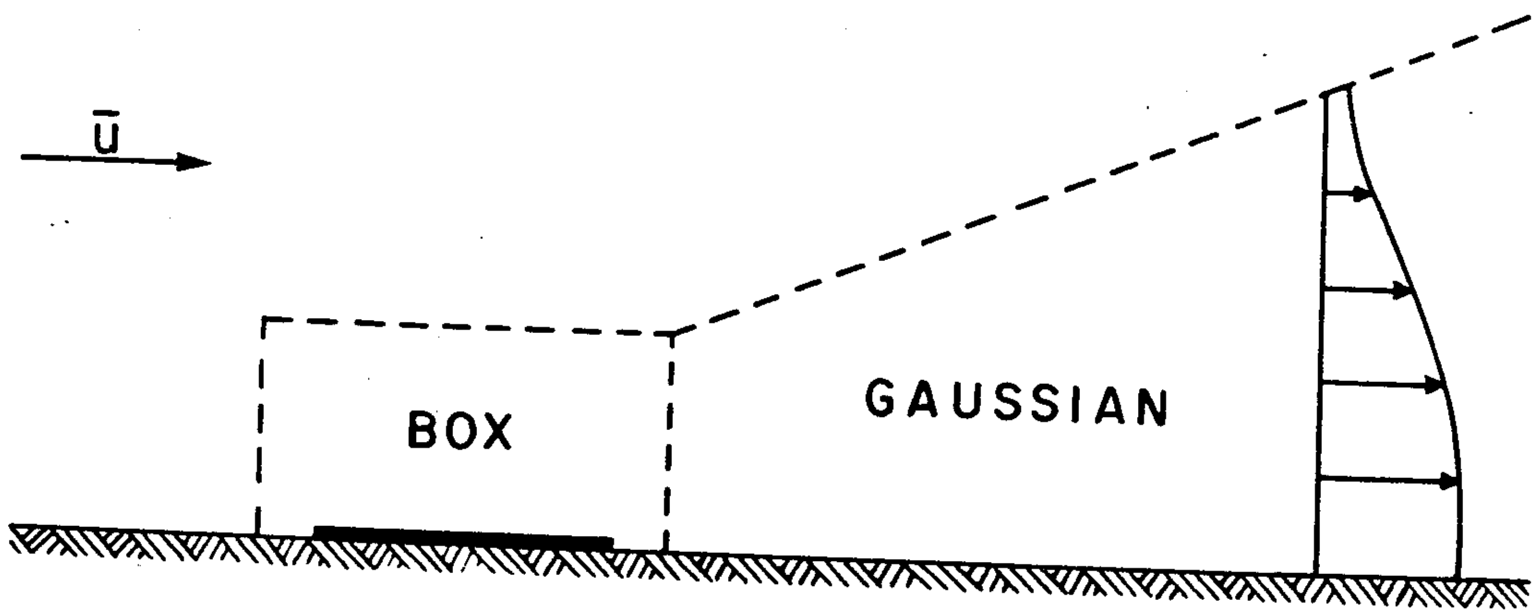


FIG. 57 CALINE MODEL COMPONENTS FOR CROSSWIND CONDITIONS

Different relationships were derived for stability A, B, and C-D combined. Not enough data were gathered to reliably determine separate relationships for stabilities E and F, however. Until further data are obtained, it is assumed that the relationship derived for stability C-D can be used for stability E or F.

In order to incorporate this change in the microscale modeling analysis, a CO reduction factor was developed. This transposes the mixing cell concentration on the highway within the depressed section into an imaginary mixing cell at the same height as the surrounding terrain (Figure 58). The Gaussian dispersion equation is then used to calculate concentrations downwind from the depressed section. The CO reduction factor was derived from the CO concentrations measured at 4 feet, 12 feet, 20 feet, 36 feet, or 44 feet (1.2 m, 3.7 m, 6.1 m, 11.0 m, or 13.4 m), divided by the CO concentration at 4 feet (1.2 m). The reduction factor for 4 feet (1.2 m) is 1.0 and for any height above 4 feet (1.2 m) is less than 1.0.

In almost all cases observed for the depressed section sites, the carbon monoxide concentration decreased with height. This decrease was gradual in the bottom 12 feet (3.7 m), reinforcing the concept that a uniform mixing cell concentration exists. There were, however, a few cases where aerodynamic eddies caused some increase in CO concentrations with height. These cases were excluded from the analysis and will be subject to future research.

The revised version of CALINE 1 incorporating the CO reduction factor enabled the prediction of carbon monoxide as close as the top of the cut section. Previous estimates were available no closer than 100-200 (31-61 m) feet downwind from the top

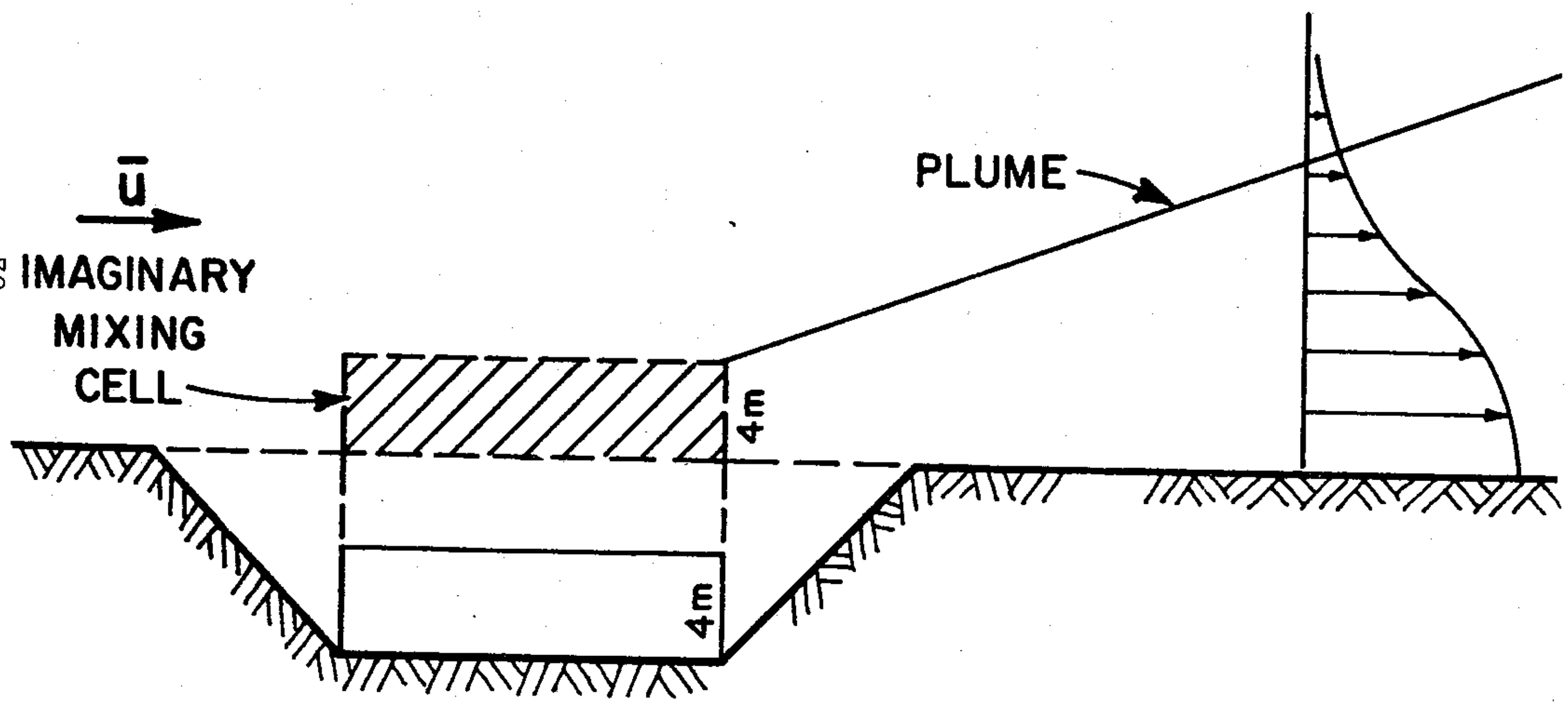


FIG. 58 IMAGINARY MIXING CELL FOR DEPRESSED HIGHWAY SECTIONS

of the cut, depending upon the atmospheric stability class(2d). But the improved model, while a significant improvement over the original method, still did not adequately handle the parallel wind component. A further modification was necessary to improve parallel wind predictions.

The latest model, called CALINE 2, calculates carbon monoxide concentrations for any wind angle, using a weighted sum of the "pure" crosswind case and the "pure" parallel wind case for each receptor. The "pure" crosswind concentration is obtained using the existing Gaussian theory for an infinite line source. The "pure" parallel wind concentration is calculated by summing an "infinite" number of area sources used to represent the line source. The two concentrations are then summed using weighted factors obtained from the trigonometric identity,

$$\cos^2\phi + \sin^2\phi = 1$$

The factor $\cos^2\phi$, is applied to the parallel wind component, and the factor $\sin^2\phi$, to the crosswind component.

An additional improvement incorporated into the parallel wind calculation for CALINE 2, is the capacity to handle differing highway widths in a dynamic manner. The initial portions of the horizontal dispersion parameter curves, σ_y, are adjusted to begin at the σ_y corresponding to the mixing cell width, the latter being calculated from the highway width.

With these improvements and a few minor refinements of the equations used to represent the Gaussian theory in the internal workings of the model, CALINE 2 represents a much more general approach. Initial correlation studies indicate, in general, good agreement between measured and observed values, and show the improved predictive capability of CALINE 2 over the previous version (see Figures 59 through 61). Refer to (3) for more details of CALINE 2 and its validation.

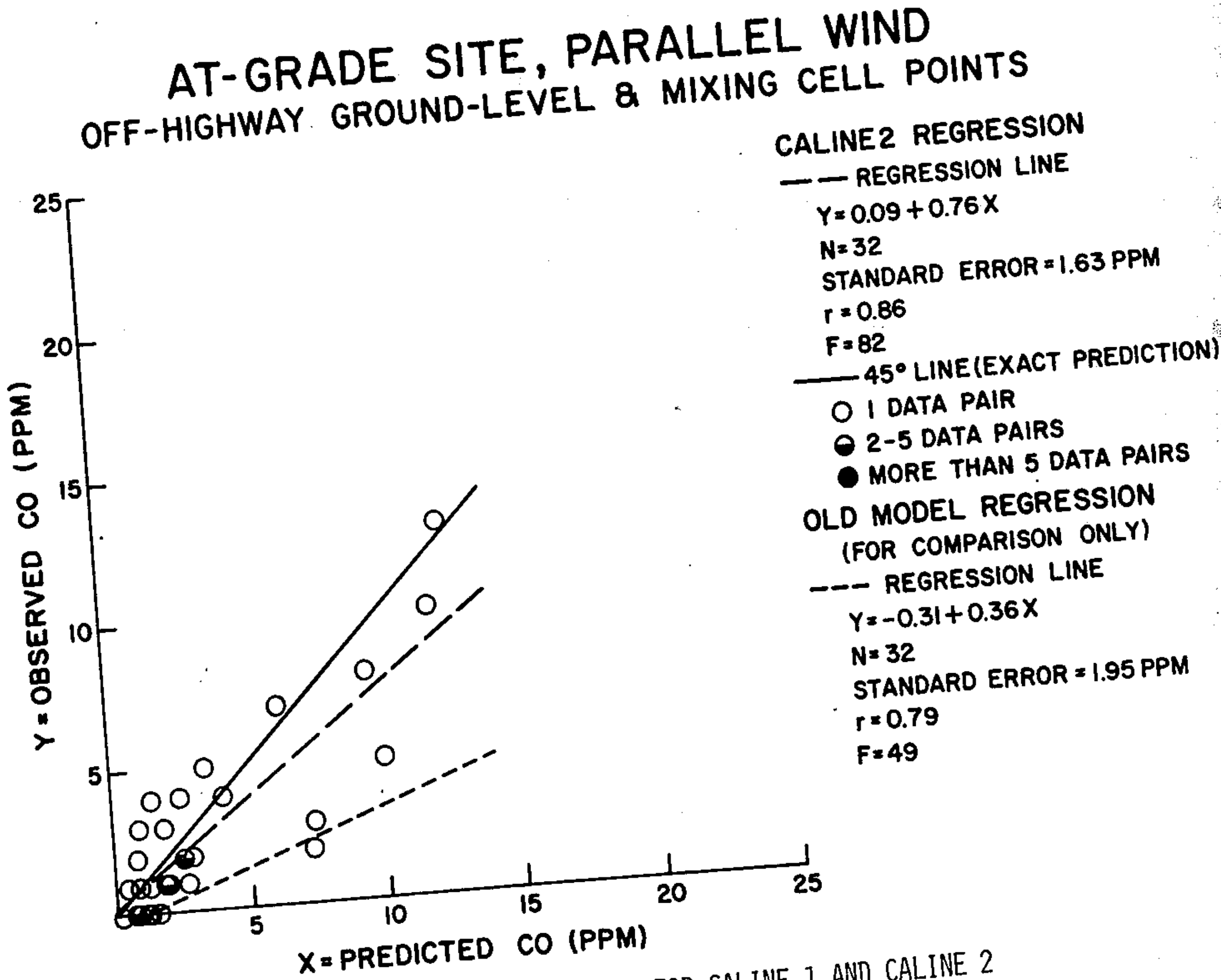


FIG. 59 PREDICTED VS. OBSERVED VALUES FOR CALINE 1 AND CALINE 2 DATA FROM RESEARCH SITE 3

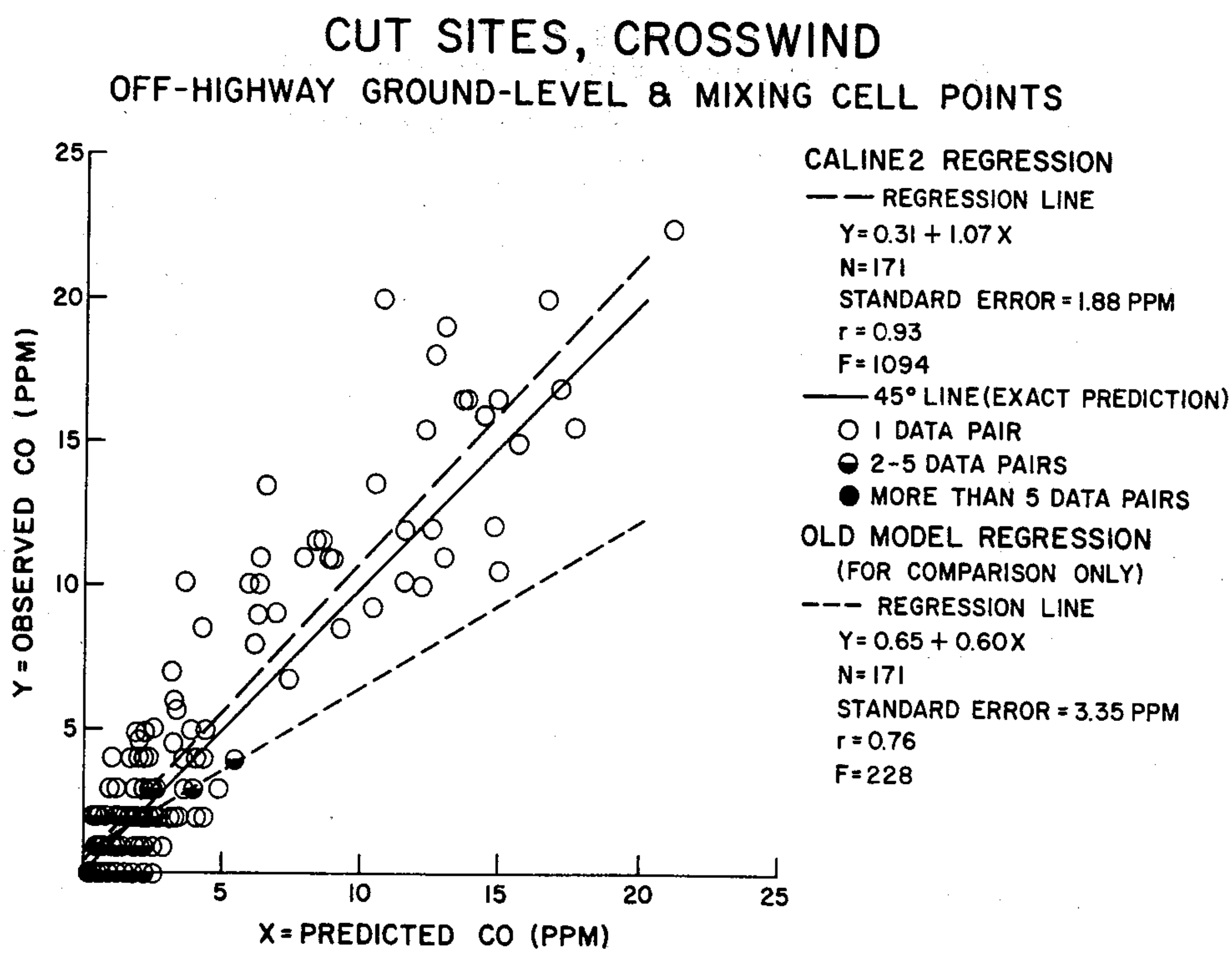


FIG. 60 PREDICTED VS. OBSERVED VALUES FOR CALINE 1 AND CALINE 2 DATA FROM RESEARCH SITE 2

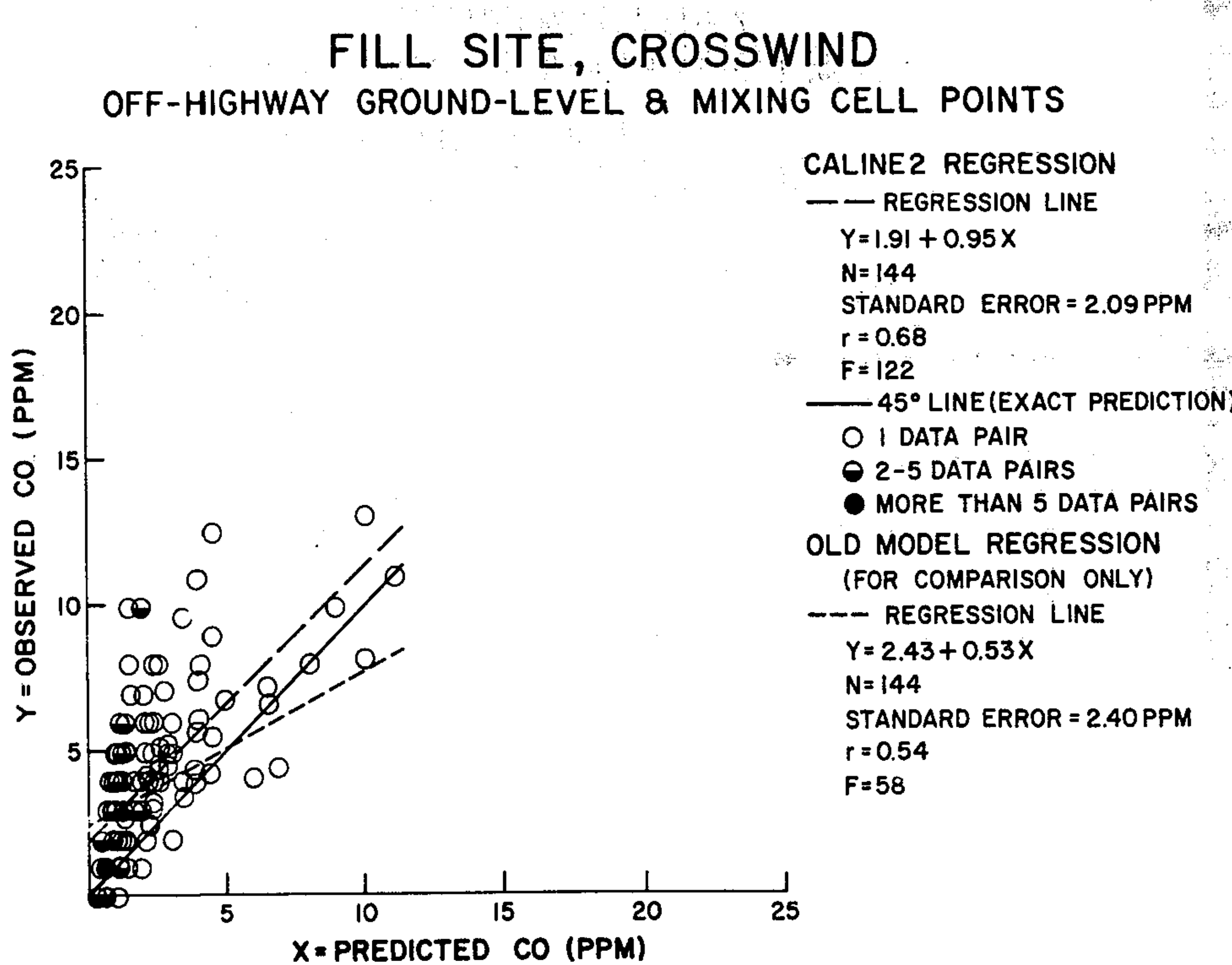


FIG. 61 PREDICTED VS. OBSERVED VALUES FOR CALINE 1 AND CALINE 2 DATA FROM RESEARCH SITE 5

PRELIMINARY EVALUATIONS OF OTHER LINE SOURCE MODELS

AeroVironment

AeroVironment Incorporated, under contract with Caltrans District 04, has developed a line source model for air quality impact studies. Reference 6 discusses the theory and development of the AeroVironment model. It can be used only for at-grade freeway sections, but has the capability for including surface roughness heights in its analysis. However, a sensitivity analysis made by the Transportation Laboratory indicates that the model is not sensitive to this input parameter.

The input to the model includes the following:

1. Wind speed
2. Angle of wind to roadway
3. Radiation flux
4. Reference roughness
5. Actual roughness
6. Ratio of vertical to horizontal dispersion speeds
7. Vehicles per hour
8. Emission factor
9. Background level
10. Coordinates of Plane 1 to road segment

Initial model evaluation, using data from the bag study, shows that the model performs quite well at downwind receptor locations, Figures 62 and 63.

Systems, Science and Software

The Systems, Science and Software (S^3) conservation of mass line source model was developed for the California Air

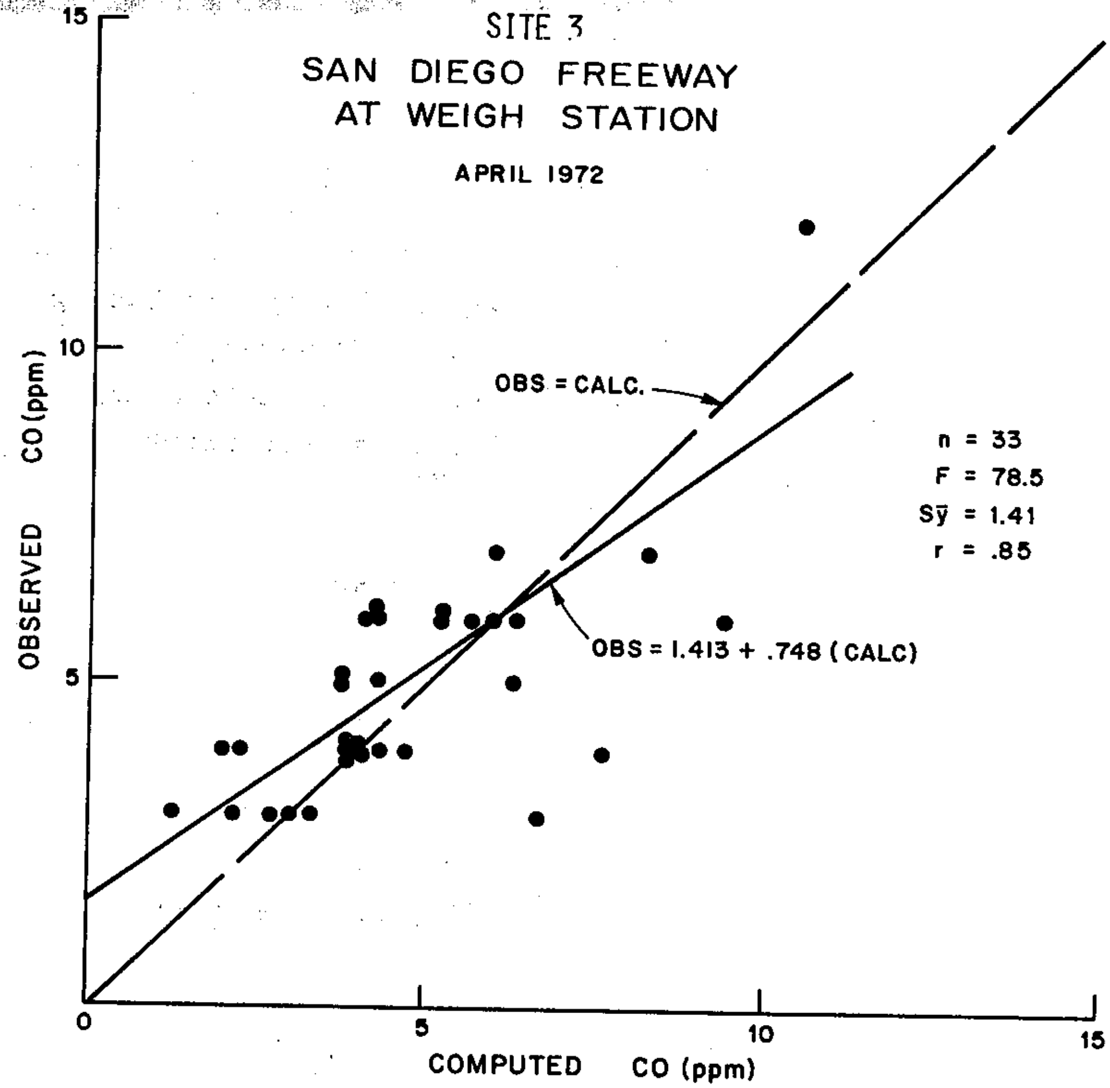


FIG. 62 AEROV VS. SITE DATA AT 100' FROM EDGE RDWY. FOR CO

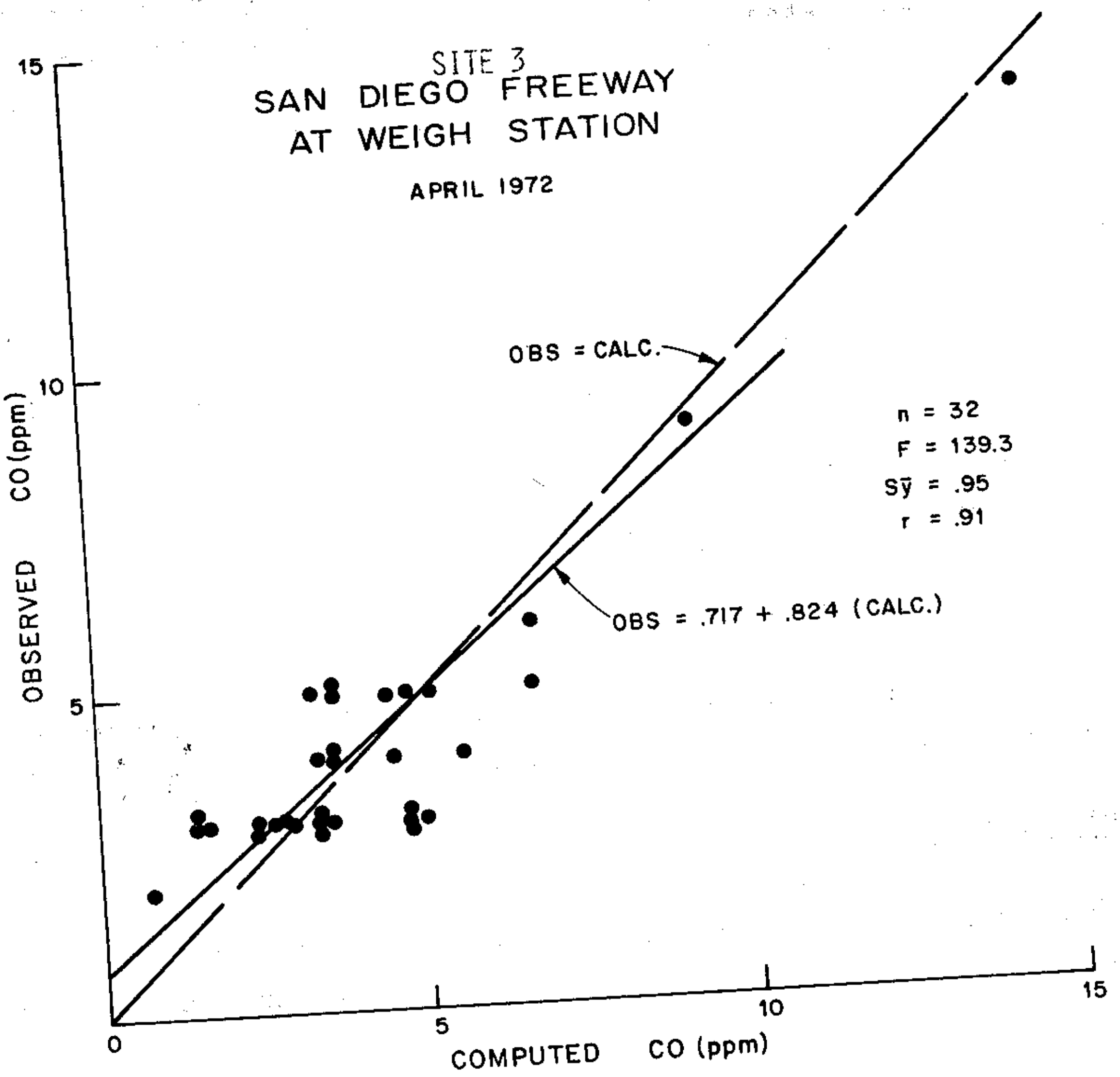


FIG. 63 AEROV VS. SITE DATA AT 200' FROM EDGE RDWY FOR CO.

Resources Board. Reference 7 documents the theory and use of the model. It can be used for all types of highway sec but further work may be necessary before this model gives accurate predictions. Refer to Figures 64 through 67 for plots of calculated value versus actual value. These plot were obtained from Reference 7.

The inputs required to run this model are:

1. Grid height and length
2. Roadway height and width
3. Stability class
4. Wind profile
5. Diffusivities
6. Terrain features
7. Wind speed and direction
8. Emission factors
9. Vehicles per hour

Except for diffusivities, all the above values are readily available at this time to operate the model.

EPA Highway Model

The Highway Line Source Model developed by EPA was not evaluated with the data from the initial bag sampling portion of this study.

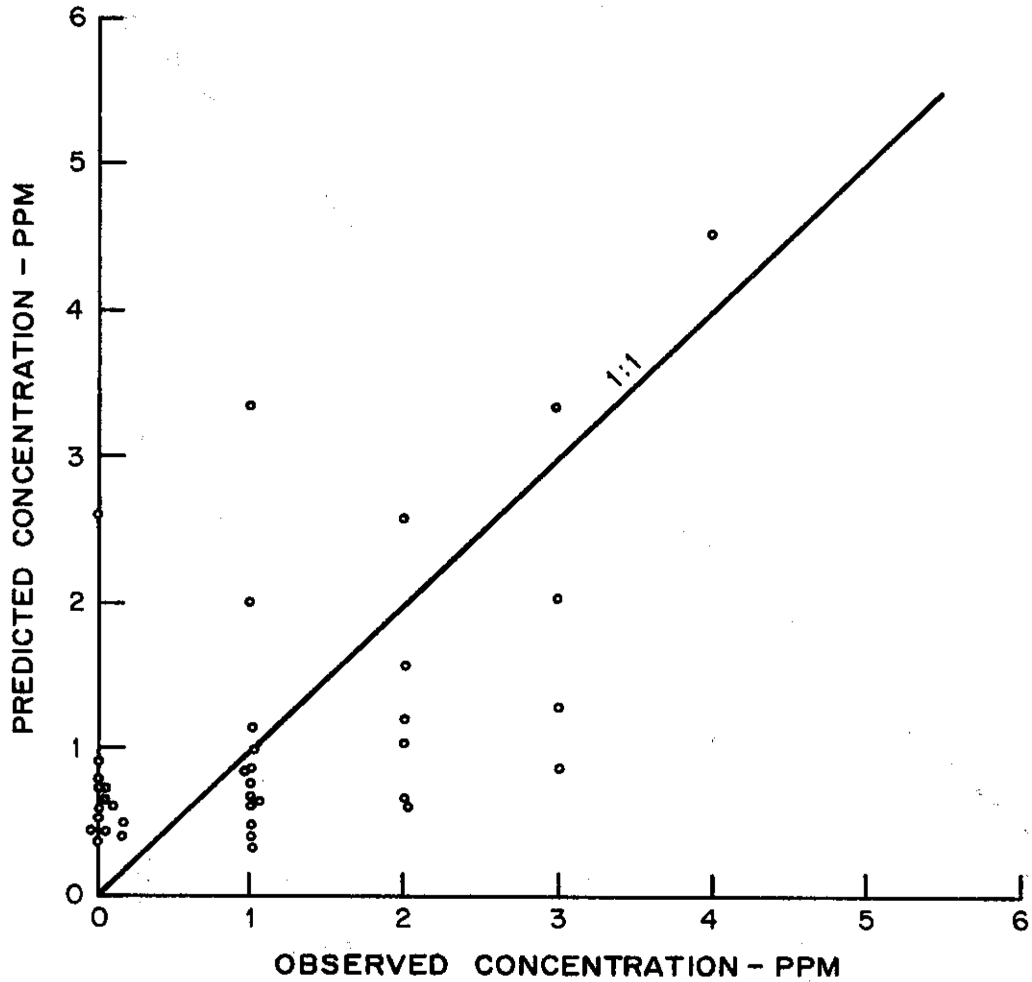


FIG. 64 PREDICTED VS. OBSERVED CO CONCENTRATIONS FOR S3 MODEL, AT-GRADE SITE

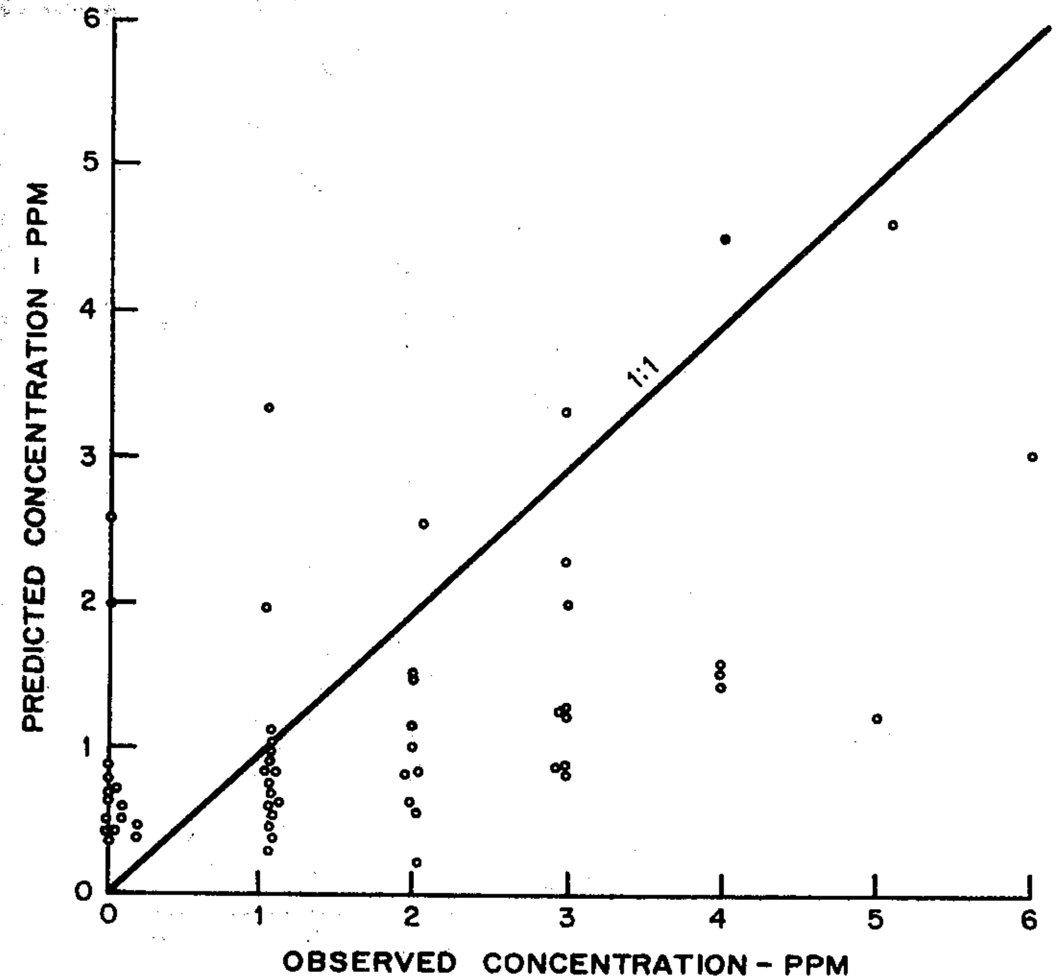


FIG. 65 PREDICTED VS. OBSERVED CO CONCENTRATIONS FOR S^3 MODEL, AT-GRADE SITE INCLUDING ROAD EDGE POINTS

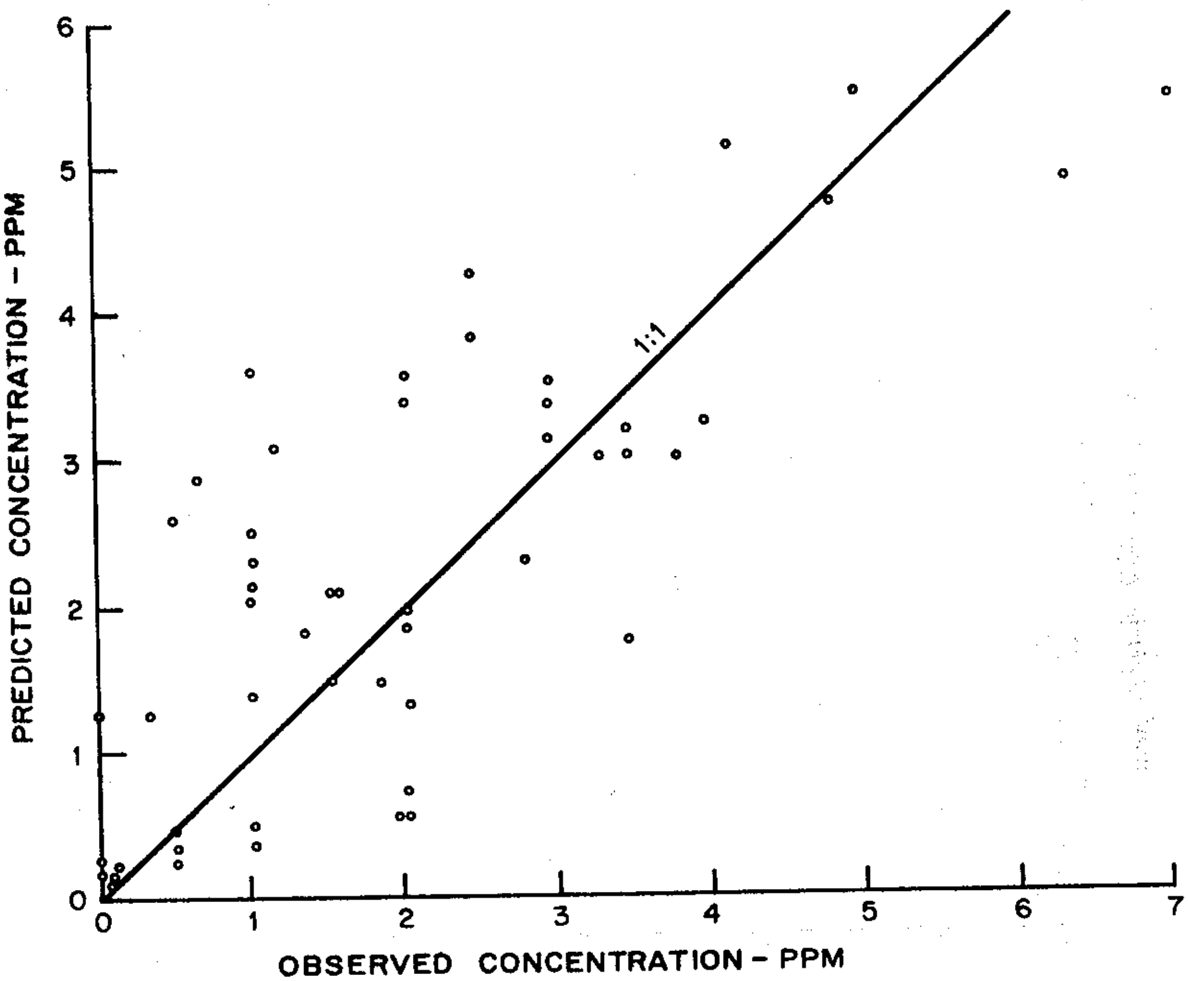


FIG. 66 PREDICTED VS. OBSERVED CO CONCENTRATION FOR
FOR S³D MODEL, DEPRESSED SECTION

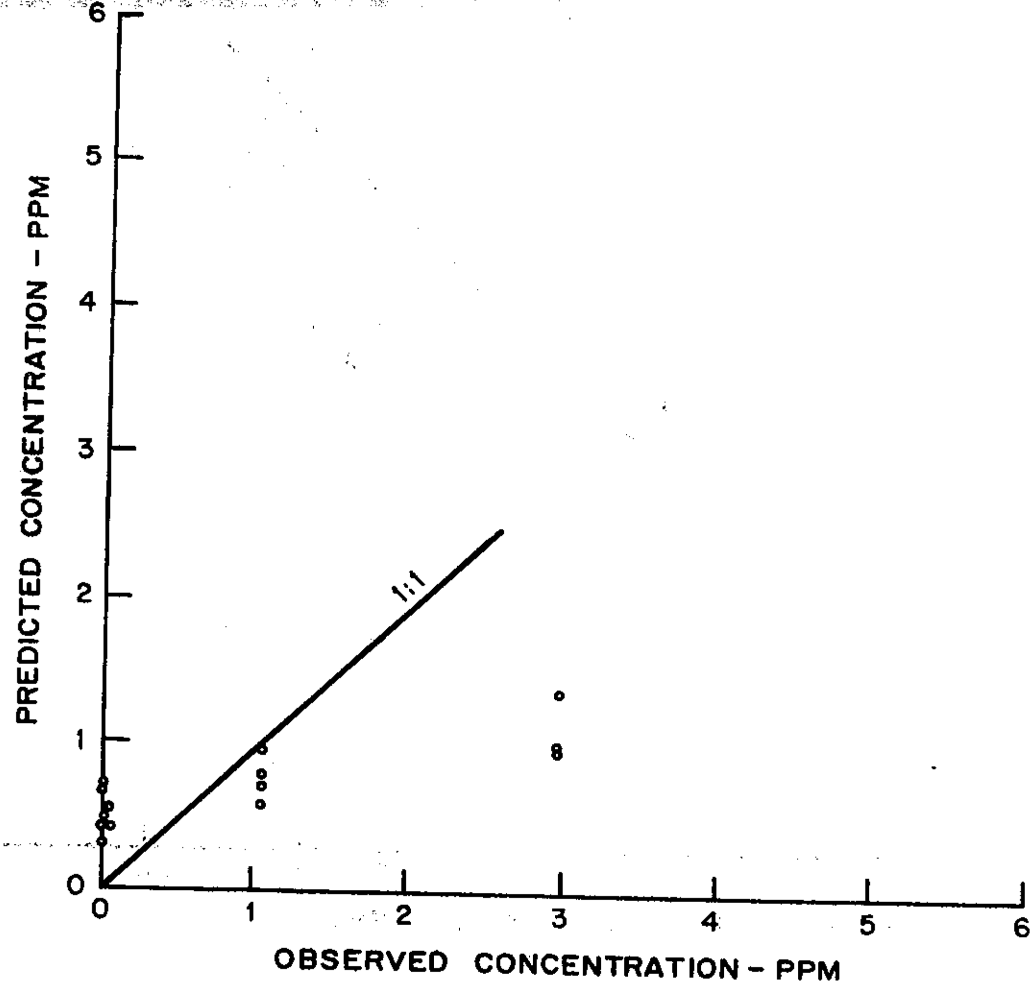


FIG. 67 PREDICTED VS. OBSERVED CO CONCENTRATION FOR S^3 MODEL, FILL SITE

AIR MONITORING VAN DESIGN CONSTRUCTION AND OPERATION

..e objective of the research project "---- to monitor vehicular generated air pollutants around a roadway section and to document their dispersion into surrounding areas ----" required a mobile laboratory to house the sensitive electronic equipment to perform the on-site analysis. Therefore, the following standards were established to regulate the vehicle design:

1. Self powered for ready mobility.

2. Self-contained for continuous equipment operation during moving.

3. Sized for instrumentation to allow all possible pollutant and meteorological measurements related to vehicle air pollution.

4. Fully insulated and air conditioned to provide climate control including heating.

With these guidelines, the vehicles purchased were two 30 foot (9.1 m) motor homes with open interiors (see Figure 68), a 15 KW, 115-230V A.C., gaspowered generator, and two 14,000 BTU roof-mounted air conditioners. These vans are of typical motor home construction, aluminum skin, wood 2" x 2" (50 mm x 50 mm) framing, and 1/4" (6 mm) finished plywood paneling interior. The walls, ceiling, and floor were insulated with 2" (50 mm) polyurethane to reduce heat transfer.

The generator is powered by a 4 cylinder gas engine that operates off a separate 50 gallon (189 litre) fuel tank. The generator is sized to carry the air conditioners and all

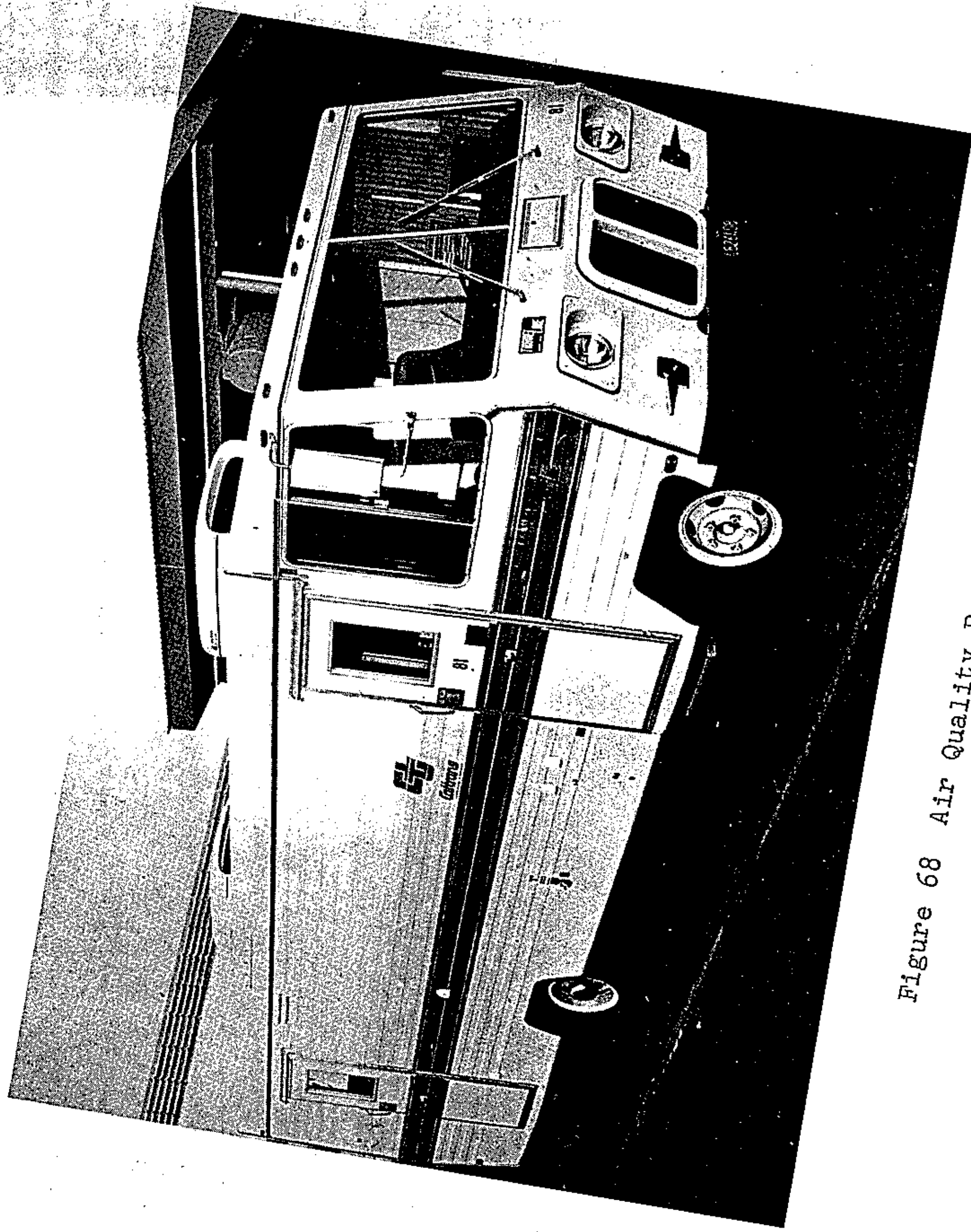


Figure 68 Air Quality Research Van

internal equipment so that the van can operate independent of outside power sources.

External modifications to the van include the mounting of a mast for meteorological equipment and the required connections for wiring to such sensors. Also included are AC power outlets for sensor support. These outlets include one ground-fault interrupt system for AC power to be supplied where the public might have access to cables or sensors; this will prevent electrical shock, even if exposed cables are cut, due to the instantaneous power disconnect upon grounding.

Other outlets through the van walls were limited to instrument vents and one inlet fitting for ethylene. The ethylene cylinder and regulator are enclosed in a portable box for protection. This is necessary as ethylene is considered an explosive gas and cannot be contained or transported in the passenger compartment of any motor vehicle by state law.

The main vacuum pump, bag box vacuum pump, and the air compressor are mounted under the body and suspended from the vehicle frame.

The main support system necessary for all equipment operation is the electrical supply. The power wiring for electronic equipment and the air conditioner-heater operation was divided into separate phases to isolate power demand fluctuation which would possibly affect data output. In addition, various components were divided into several fused circuits to segregate them into equal loads with the least interference factors.

The actual wiring is split down each side of the van and terminated in receptacles for all major components. One central panel on the desk top remotely controls all electrical systems. Eight switches handle low voltage to relays which switch the 110V A.C. At instrument and pump locations, additional switches allow individual switching as may be necessary during calibration or partial operation. With this type of switching, the hard wiring then passes down both sides of the van and crossovers are not required. The relay wiring is included into the solenoid control wiring ducts which cross overhead attached to the ceiling. The function of the central panel provides a ready access to all electrical circuits for convenience and emergency shutdown if trouble develops.

The interior design concept is one of central operation focus with access to equipment for ease of maintenance. Therefore, the central point lies between the operation display board and the computer system control (Figures 69 through 71).

As the research testing plan requires a maximum of 15 sample input lines, the sample flow system is designed around this requirement with the versatility of monitoring fewer lines or combinations of lines.

These 15 lines are scavanged at a constant rate of 10 litres per minute to provide a real time sample to each subsystem for analysis. Occupancy time in the lines will be a maximum of 60 seconds for 600 foot (180 m) lines down to 10 seconds for the shortest lines.

The sample lines are divided into two sub-systems, the 15 line carbon monixide analysis and the 9 or 15 line bag box integrated sample (Tedlar bag collection).

The system display board (Figure 72) shows 15 sample lines, carbon monoxide analysis system, the bag box sampler system, and the secondary pollutant analysis system. The system uses solenoid valves to control air actuated valves (Figure 73).

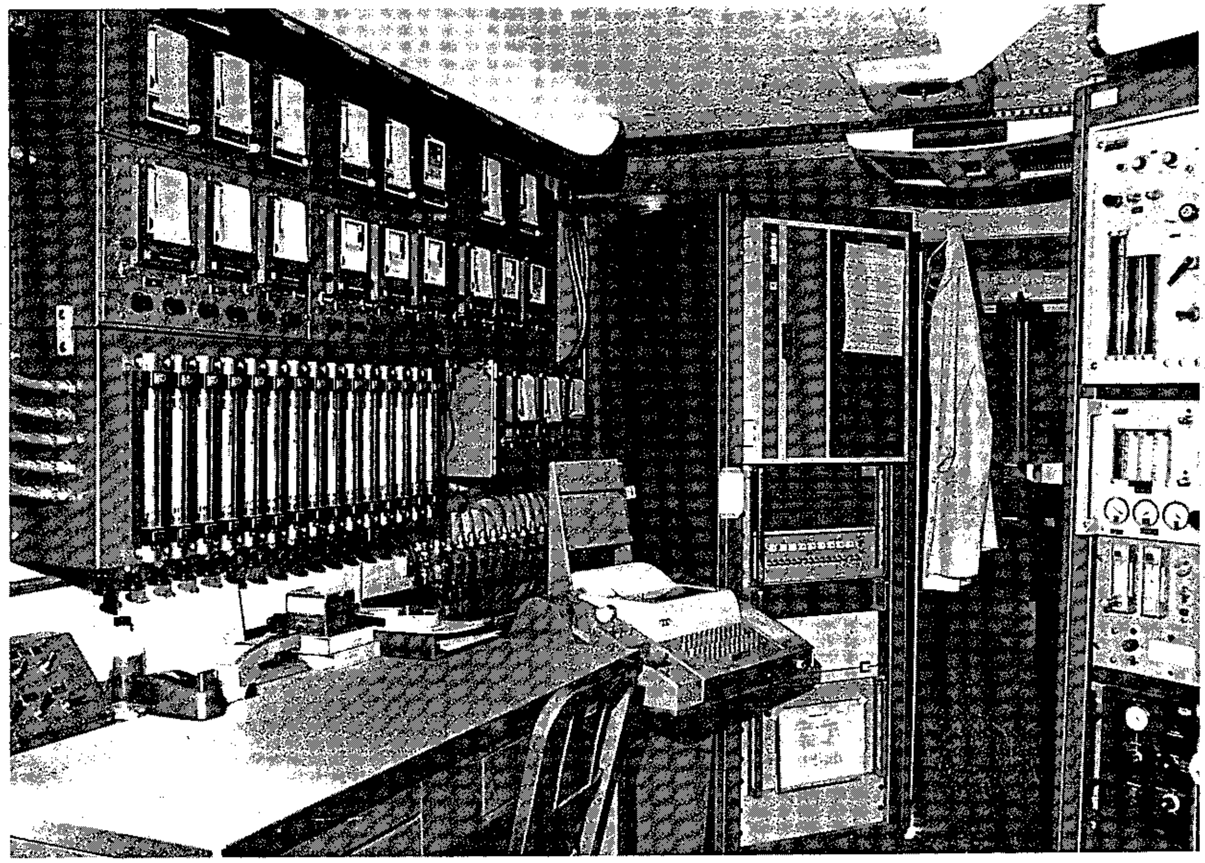


Figure 69 Central Work Area - Meteorological and Pollutant Strip Chart Recorders. Main Sample System Flow Controls. Mini Computer For Data Acquisition and Process Control.

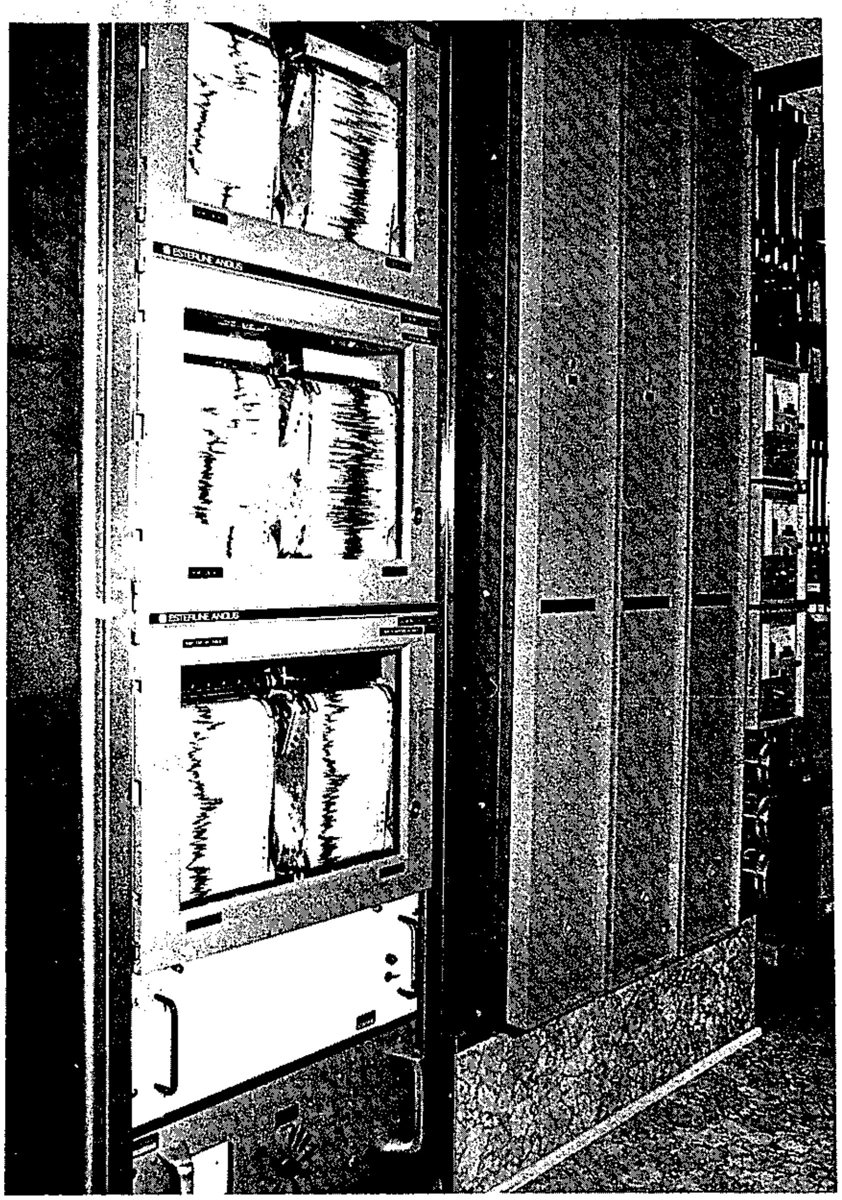


Figure 70 Meteorological Signal Conditioning
Carbon Monoxide Analyzers (Rt. Center)
UV Radiation Recorder (Lower Rt.)

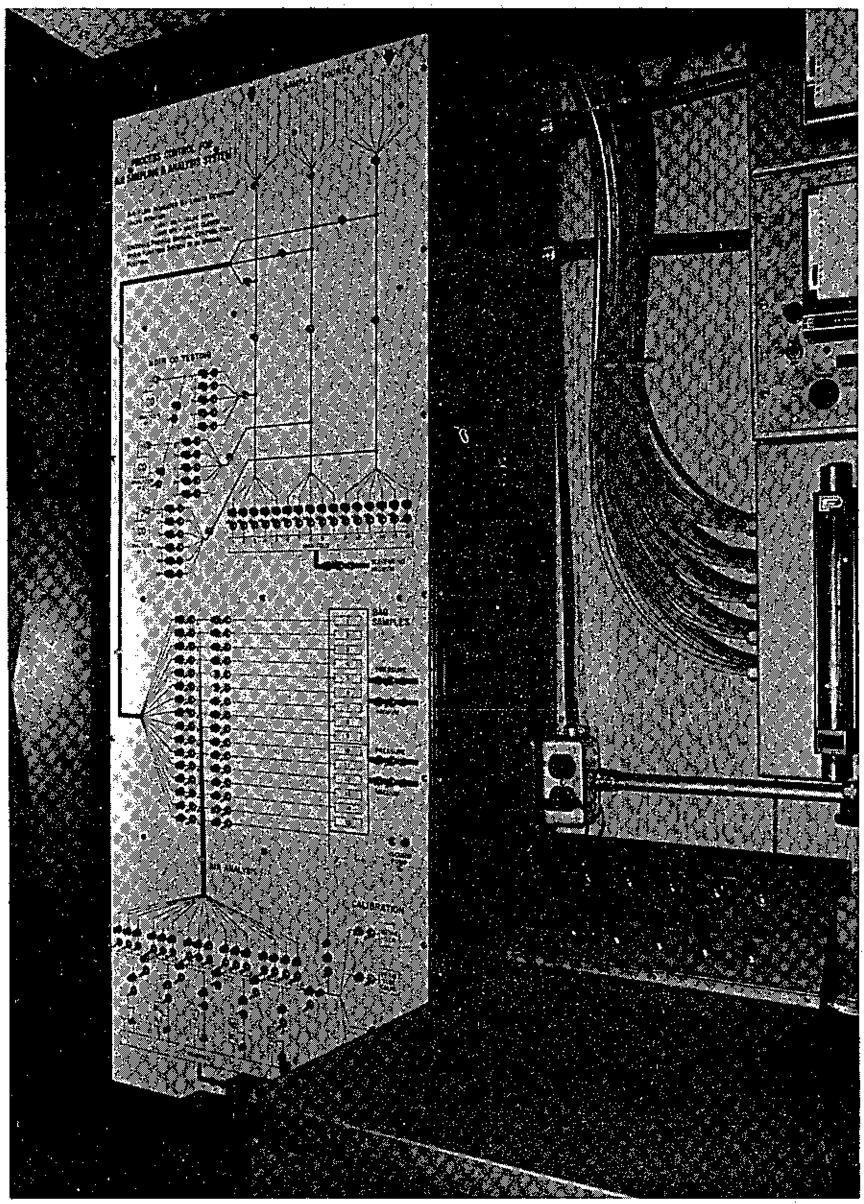


Figure 71 Air Sample Flow System, Manual Switching & Electrical Control Panel

PROCESS CONTROL FOR AIR SAMPLING AND ANALYSIS SYSTEM

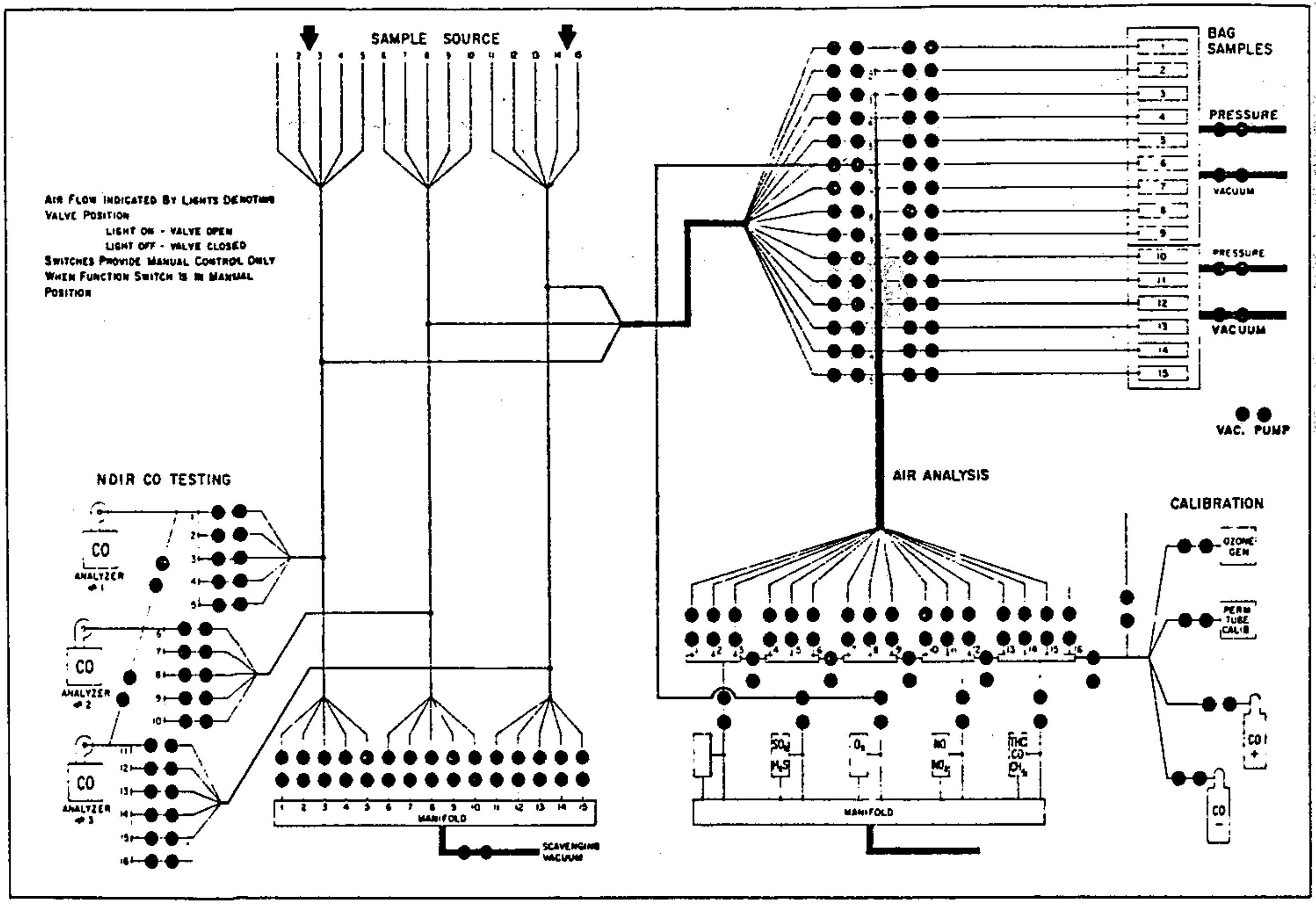


FIGURE 72

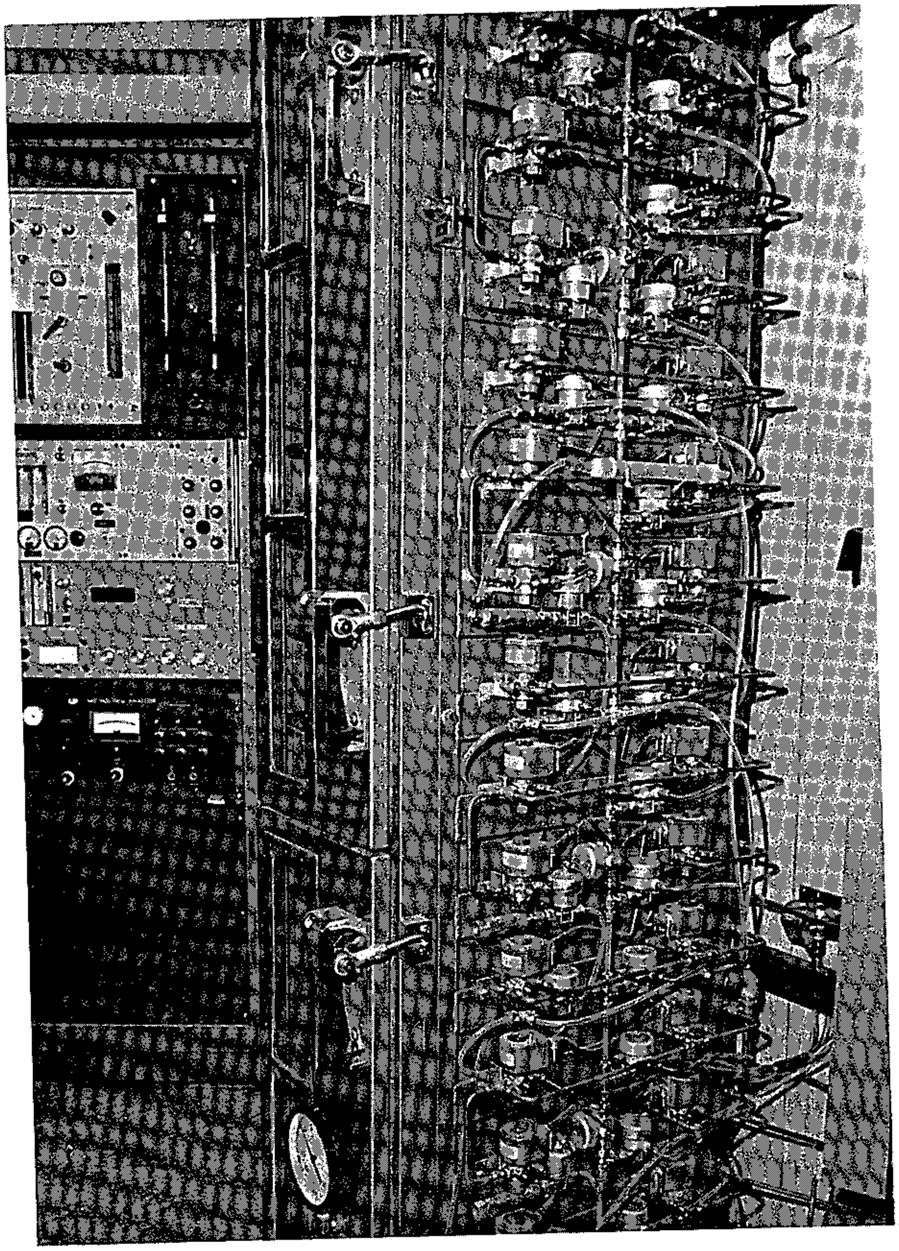


Figure 73 Sample System Plumbing with Solenoid Valves Controlling Air Activated Sample Line Valves.

All these valves are controlled on the display board by switches and have indicator lights for operation. The computer output driver interface is parallel wired to these switches to allow automatic operation of the sample flow system. Therefore, with computer software changes, the operation of the sample flow system can be changed to various sample times and patterns. These can be on magnetic tape or paper punched tape depending on origin.

The operation of the system after field testing consisted of a 1 minute sampling time for carbon monoxide for each of 15 lines. Using 3 analyzers, this allows each line to be sampled at 5 minute intervals and provides 12 data points per line per hour.

The ozone analysis and the sulfur dioxide, hydrogen sulfide analysis is done on one short line to minimize sample degradation. This sampling is continuous.

The other side of the analysis uses the bag box sampler (see Figure 74). This device takes a sample (approximately 8 to 10 litres (2.1 to 2.6 gals)) in a Tedlar bag with teflon fittings. The box is brought below atmospheric pressure by a vacuum pump by 20 to 24 inches (51 to 61 cm) of water, slightly below pressure in the sample lines. This pressure differential creates a flow into the bags at a slow rate. This is regulated by adjusting flow in the individual sample lines so that the bags are filled in approximately 15 minutes. This gives an integrated sample shown by previous statistical tests to be representative of longer integrating times.

Under the present operating conditions, 9 lines are sampled each hour through this device. Fifteen minutes are used to fill the sample bags, then the next 45 minutes of the hour

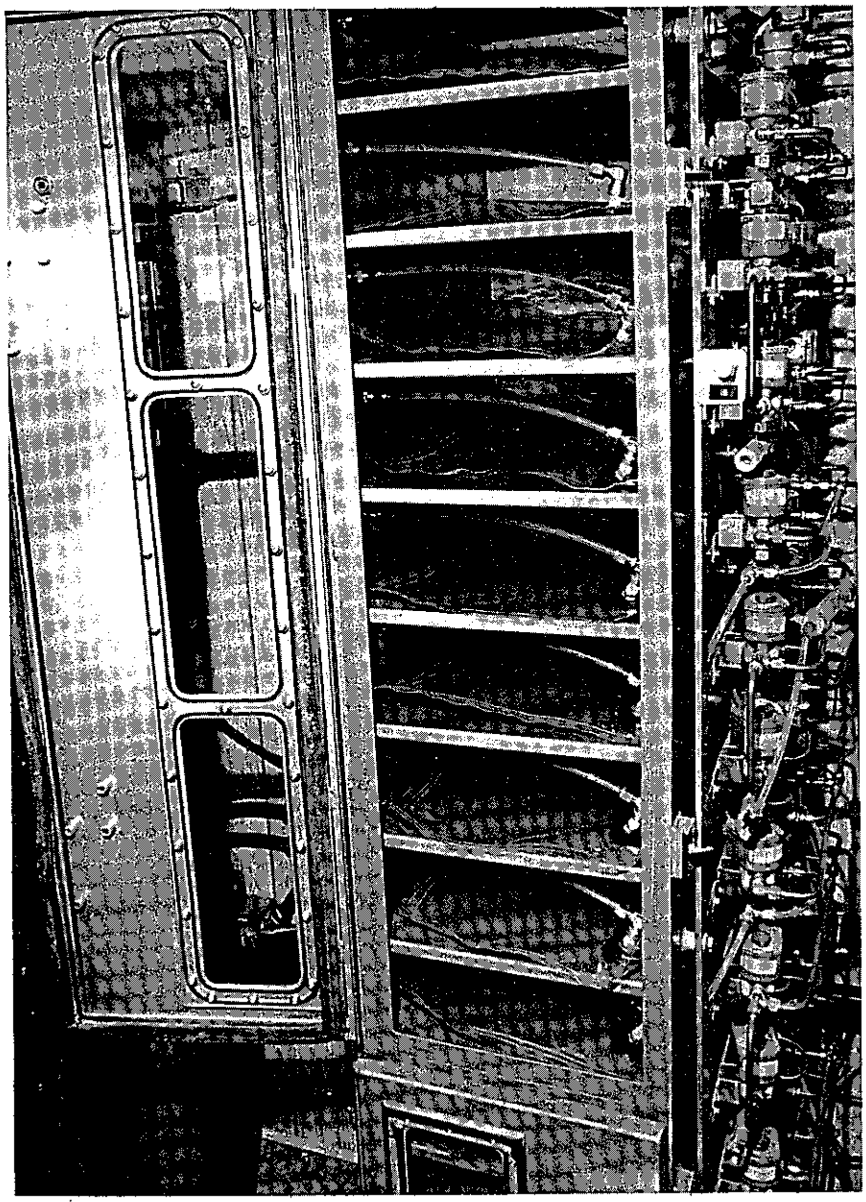


Figure 74 Tedlar Bags For Sampling NO_x and Hydrocarbons

are used for analysis. The 9 samples are analyzed for oxides of nitrogen (NO, NO_2, and NO_x) and for hydrocarbons (methane, total hydrocarbons). The analysis of hydrocarbons requires 5 minutes time per sample, therefore, 9 lines can be analyzed in 45 minutes.

The data are recorded both on magnetic tape and on paper strip chart recorders. The magnetic tape data are a parallel output from the recorder source and are obtained by the multiplexer portion of the mini-computer. Various data scan rates are used depending on sensor sensitivity, response speed and critical need for continuous record. For example, the anemometer bivane is sampled 20 times a second as it is highly sensitive and fast responding while the carbon monoxide analyzer is scanned only once a minute at the time of true value for that analysis period.

The strip chart record is used for backup and verification work, also as a trend indicator for field personnel to check instrument operation and calibration.

The strip charts are retained in Sacramento at the Transportation Laboratory in case of magnetic tape damage or- data file loss in the main processing computer.

Monitoring Equipment

A. Carbon Monoxide Analysis

Long Path NDIR (3) Beckman Model 315 BL

B. Other Gases

1. NO and NO_2

Chemiluminescence (1) Bendix Model 8101B

2. O_3

Chemiluminescence (1) REM Model 612

3. THC, CH_4, CO

Gas Chromatography-FID (1) Beckman Model 6800

4. SO_2 and H_2S

Gas Chromatography - FP (1) Tracor Model 250H

C. Particulate Sampling

High-volume Samplers (3) MISCO Model 620

D. Meteorology

Anemometer Bivane (3) Climet
Cup Anemometer (2) Climet
Temperature (3) Climet
Temperature (2) Climet
Humidity (1) Climet
Solar Radiation (2950Å-3850Å) Eppley

E. Traffic

Radar Transceiver (8) Frequency West

F. Noise

Noise Measuring Amplifier (3) Bruel and Kjaer Model 2607

G. Data Acquisition and Process Control

Processor and Power Supply Hewlett Packard 2115A
Magnetic Tape Drive Hewlett Packard 7970
Input-Output Registers Daconics
Multiplexer Redcor
Process Control Display Panel Translab
Strip Chart Recorders (26) Rustrak, Esterline-Angus and Leeds - Northrup

H. Calibration

1. Cylinder Gases

CO in dry nitrogen (various concentrations)
NO in dry nitrogen (various concentrations)
HC in air (various concentrations)

2. Generated Gases

O_3 - Ultraviolet O_3 Generator (1) REM

3, Permeation Tubes (Tracor Oven and System)

SO_2
NO
C_3H_8 (Propane)

4. Direct Current Voltage

Variable DC Voltage Standard Esterline-Angus Model V-2000

5. Electronic Substitute for Meteorological Sensors

I. Flow and Flow Control

Filters	MSA Company
Flowmeters	Fischer-Porter Company
Sample Pumps	Metal Bellows Company
Vacuum Pumps	
Tubing	Teflon (FEP) Fluorocarbon Company
Fittings	Stainless Steel Swagelock

J. Miscellaneous Support

1. Gases
   a. Ethylene
   b. Oxygen
   c. Synthetic Air
   d. Oxygen - ultra pure

2. Meteorology

   Tubular Tower 40 ft (12.2 m) length
   Tristao Tower Co.

3. Air Compressor

All instruments mounted in the van are shock-mounted either on the racks they are attached to or directly to their own housing (Figure 75). This protects electrical connections and delicate components from vibration and shock inputs. In addition, all vibration producing equipment, pumps, compressor, generator, etc. are shock mounted to reduce input vibration during the monitoring operation. For more detail regarding operation of mobile laboratories see References 4 and 5.

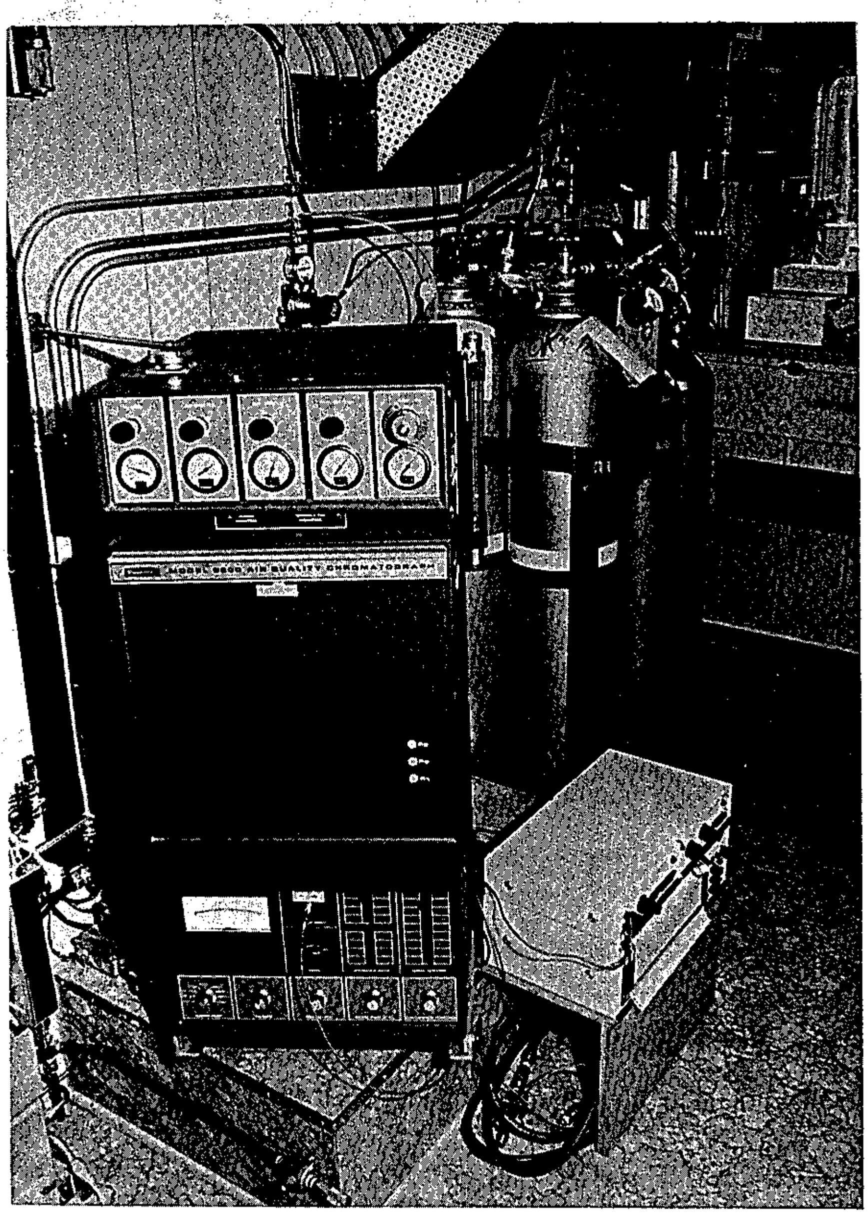


Figure 75 Hydrocarbon Analyzer with Support Gases: Zero, Air, Span, H_2 Generator Input Sample Lines (Upper Picture Center)

Field Monitoring

On site preparation for operation requires a minimum 100 amp 220 volt AC power drop, and a meteorological pole (if the 40 foot (12.2 m) van tower will not extend over the roughness elements). Some type of security should be provided, either chain-link fencing or 24 hour attendance including nighttime guard service, if necessary.

By utilizing the sampling site structures to obtain access to the roadway section, tubing can be placed into surrounding residential areas as well as around the roadway.

The sample lines vary from 600 feet to 15 feet (183 m to 4.6 m) in length. They are 3/8 inch (.95 cm) I.D. FEP type teflon, semi-rigid tubing ending with teflon filter housings (Figure 76). Most tubing is enclosed with PVC pipe for security and damage protection. The tubing runs in the gutters on residential streets as well as over the freeway on pedestrian overcrossings and down into the freeway section.

Large metal reels were designed to hold excess tubing and provide a means for collecting the tubing used at each site. Short jumper sections connect tubing on reels to the side of the van (Figures 77 through 80).

Meteorological equipment used with the van on a typical site includes two sets of wind and temperature sensors, one set for background meteorological data, the other for in and over the freeway section. The background is measured from a 70 foot (21.3 m) pole or the van mast and consists of one anemometer bivane, for vertical and horizontal wind components and true vector wind speeds, two cup anemometers and two temperature sensors separated 17 feet (5.2 m) vertically for wind shear and temperature lapse rate (Figure 81). The freeway section

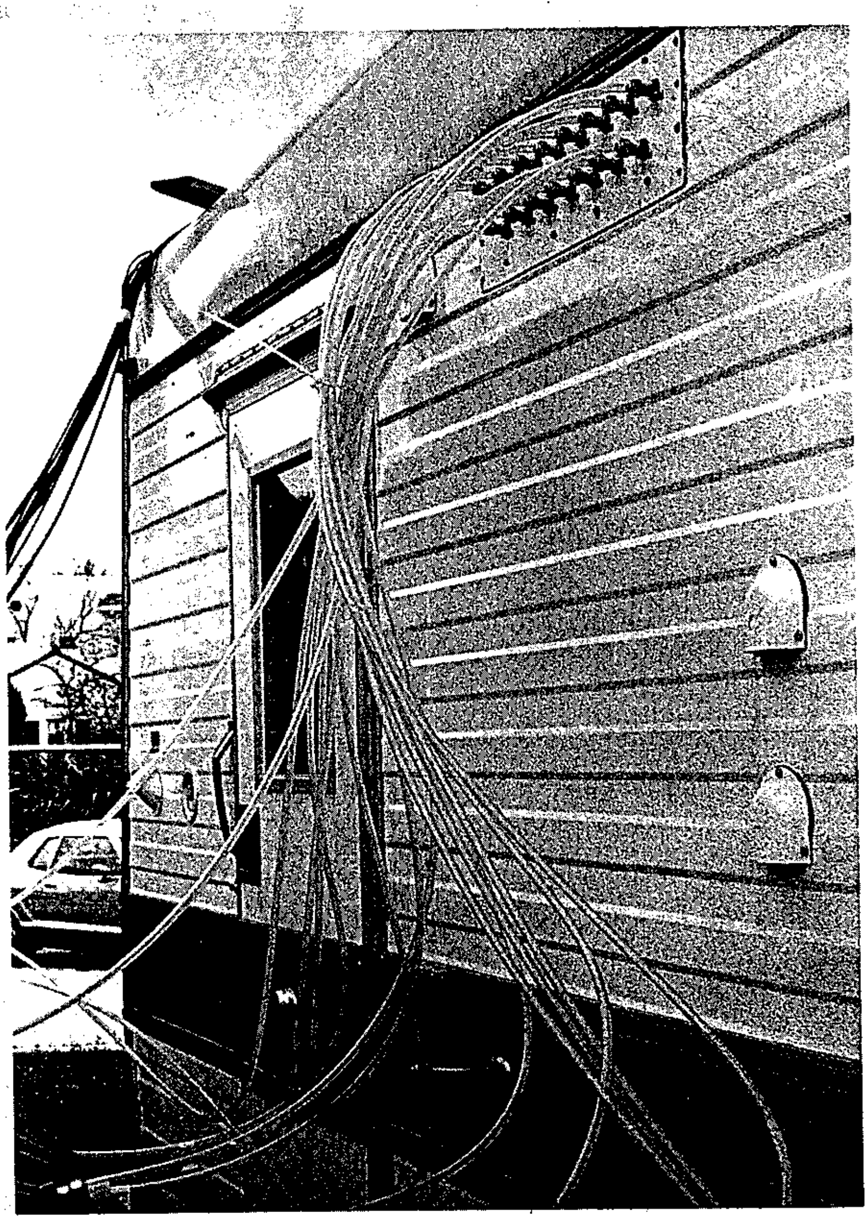


Figure 76 Exterior Sample Lines 3/8 FEP Teflon

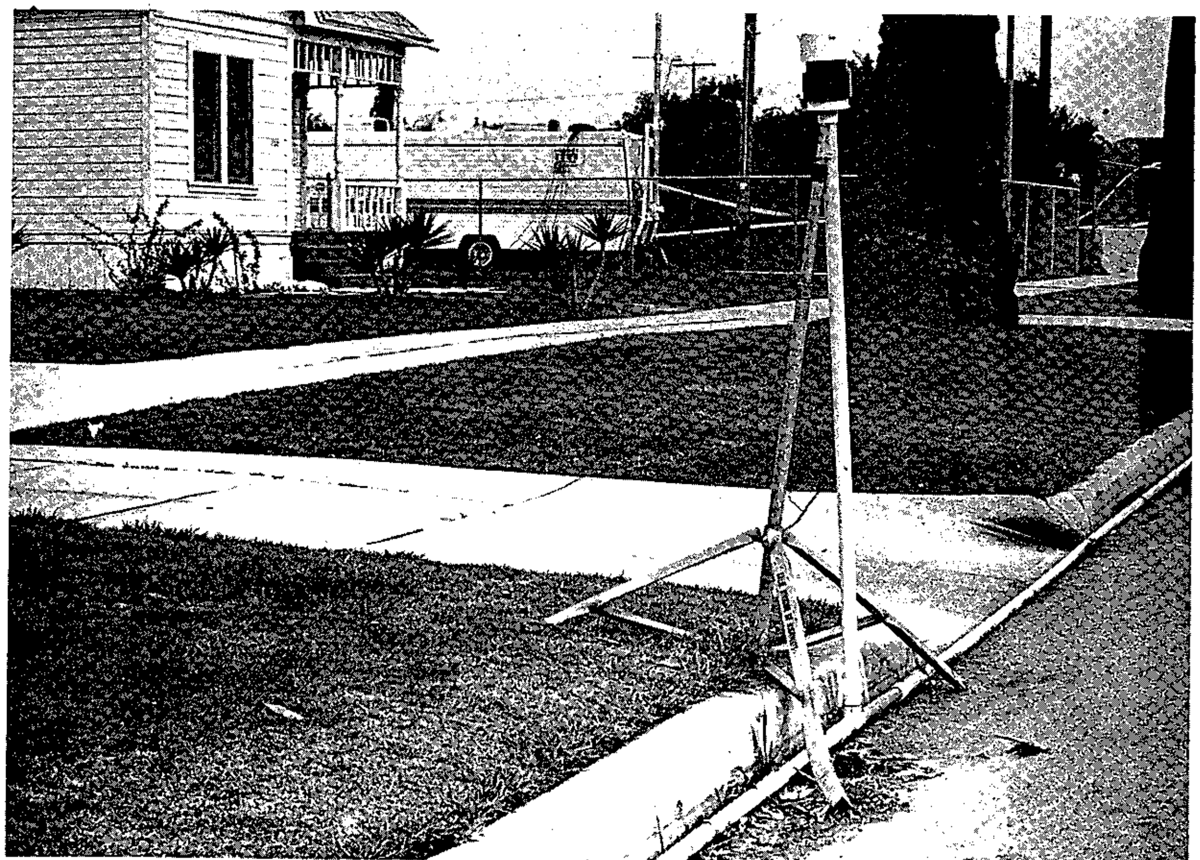


Figure 77 Typical Residential Sample Inlet

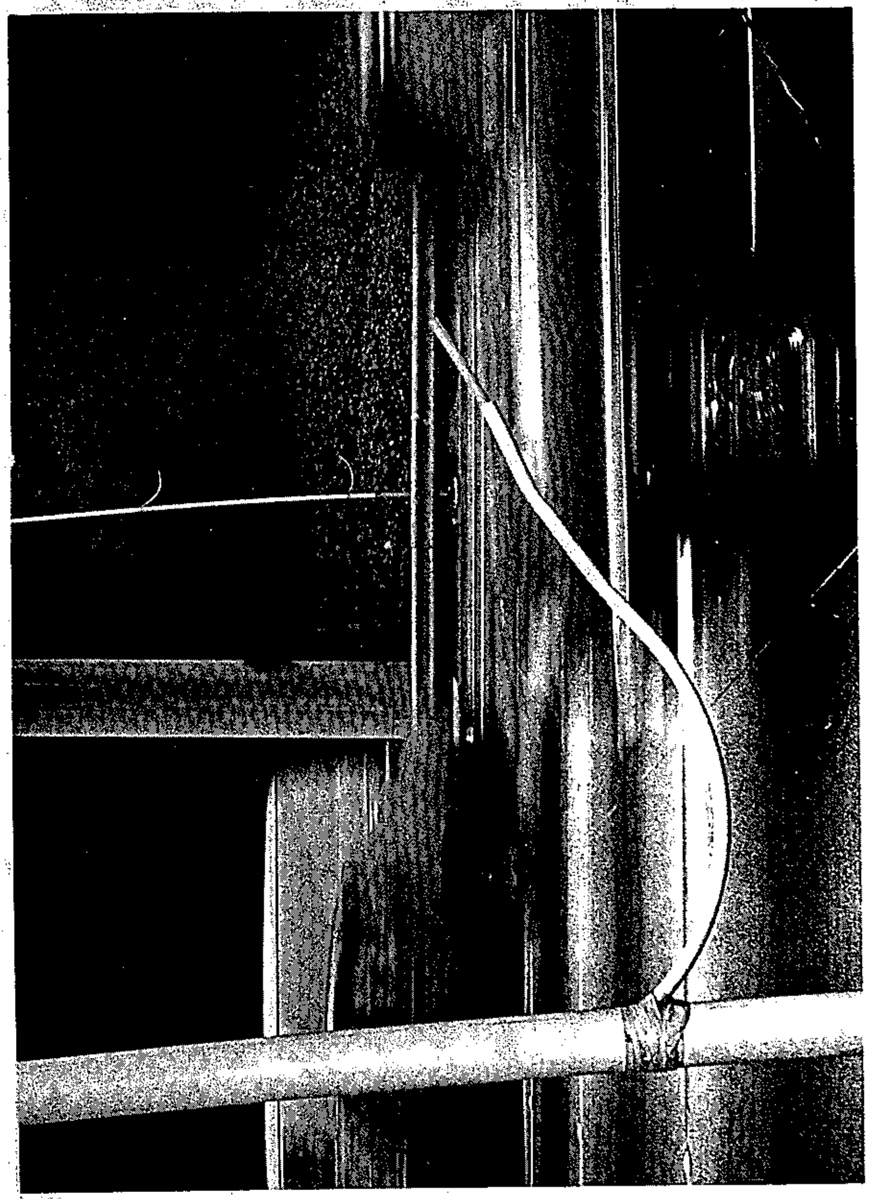


Figure 78 Sample Line Configuration Shoulder & Median

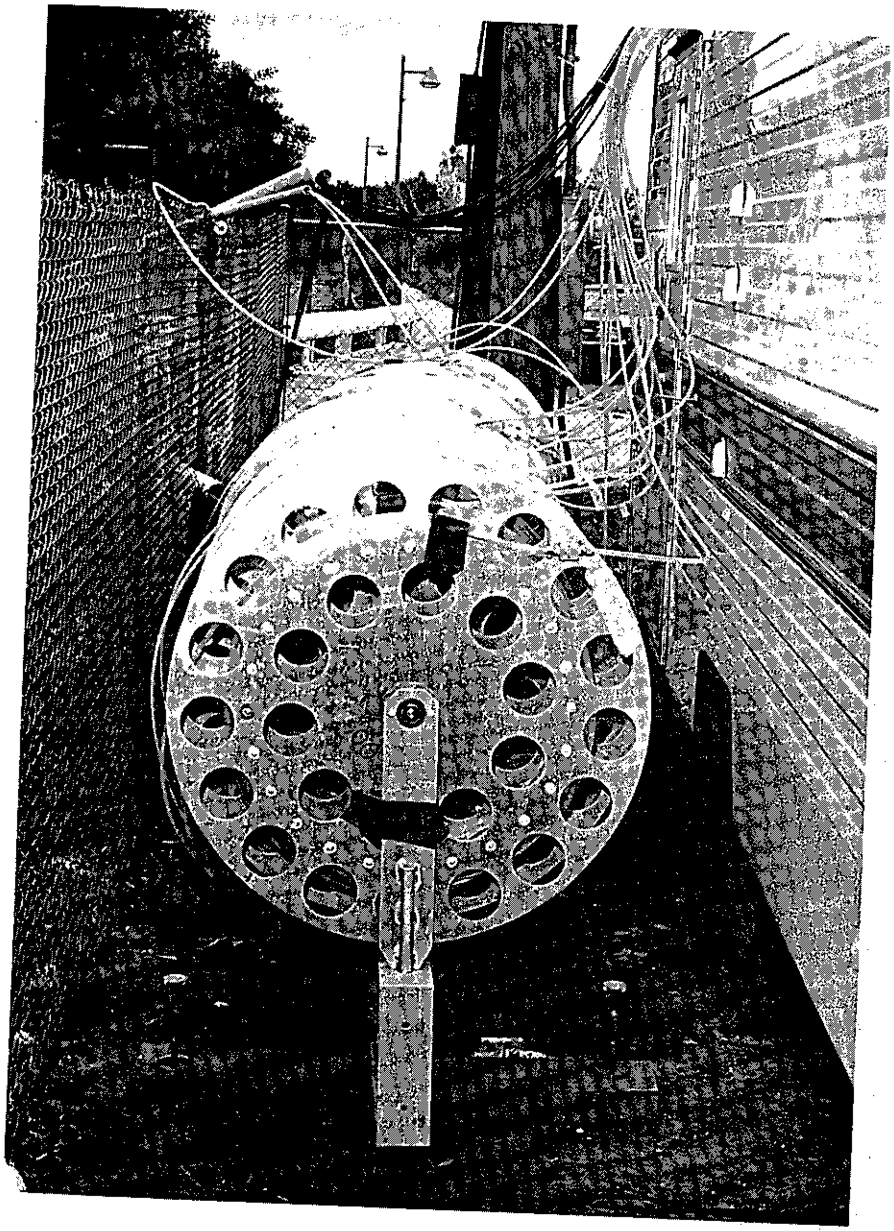


Figure 79 Storage Reels For Sample Lines (Lengths Vary From Site to Site, This is a means for Storing Excess)

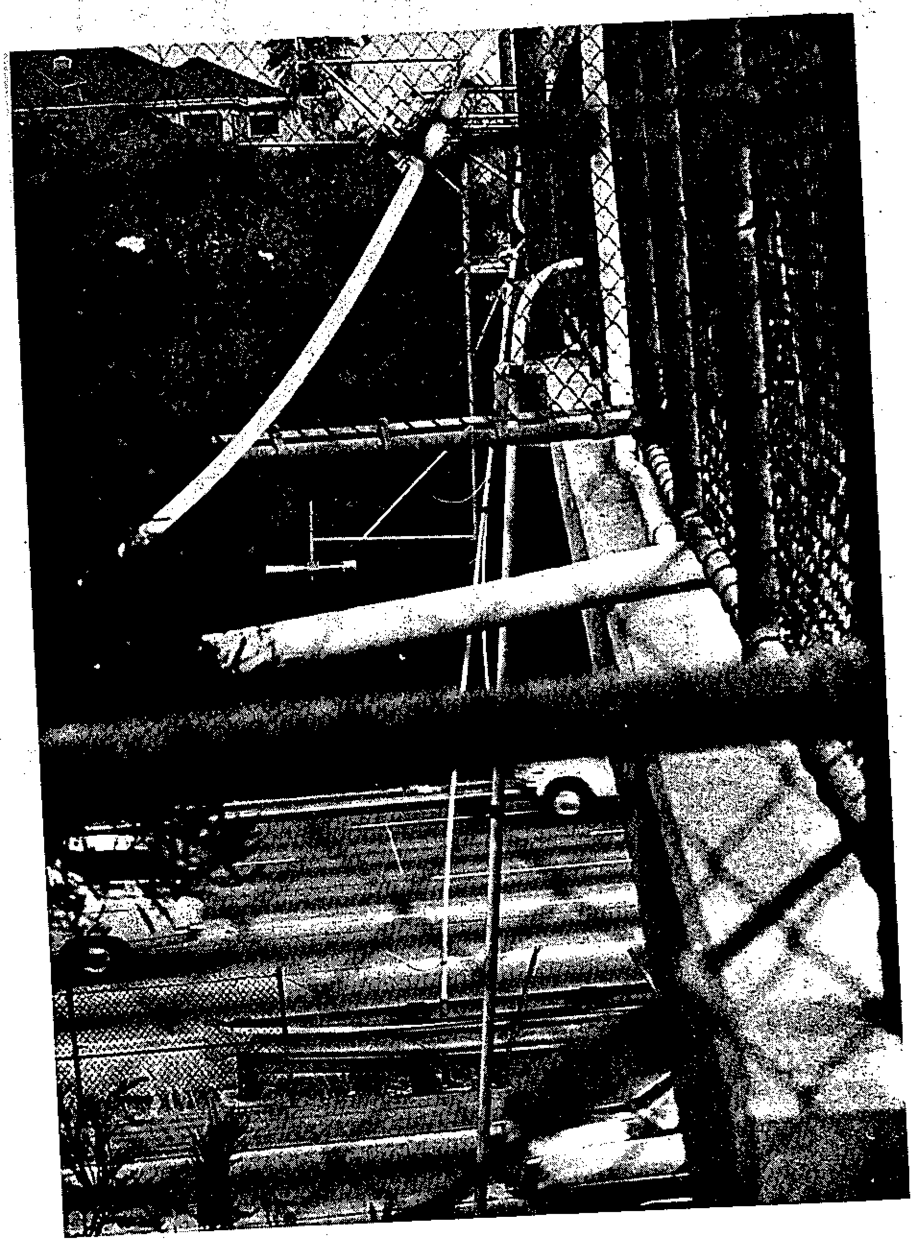


Figure 80 View Across Freeway Section

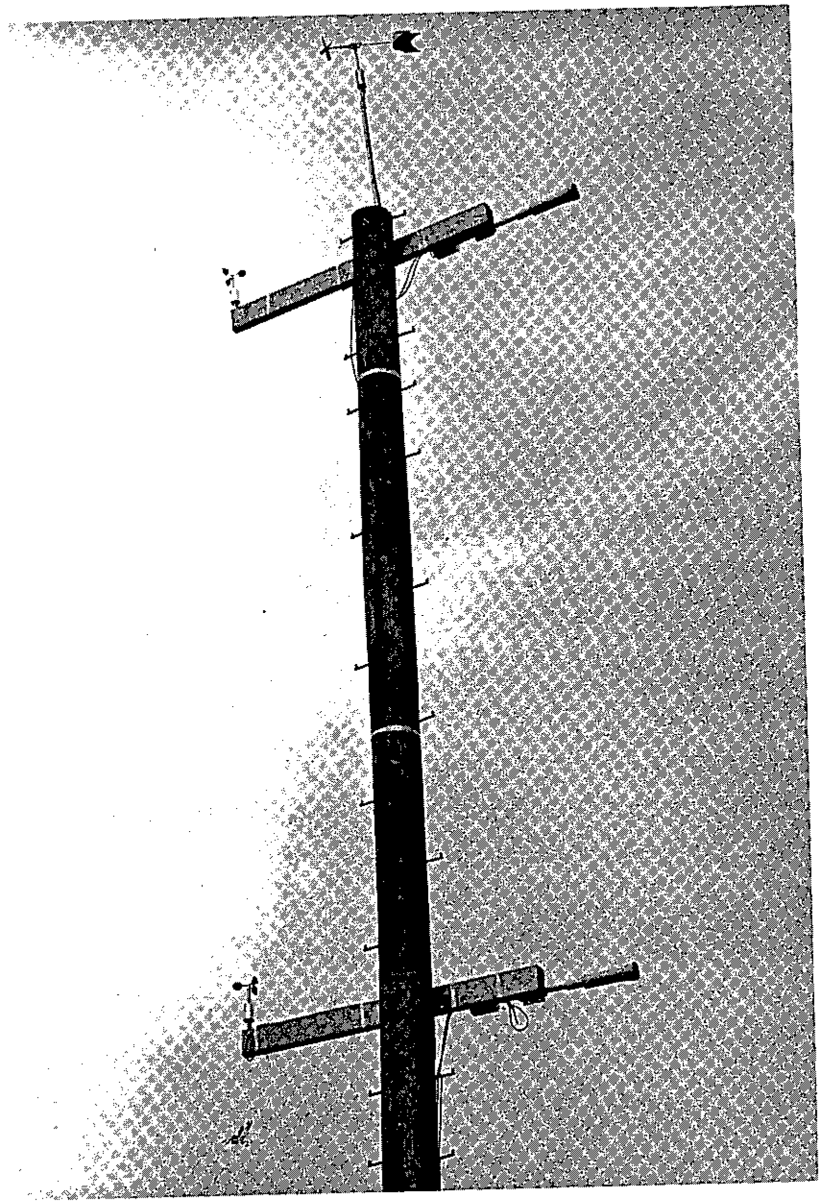


Figure 81 Meteorological Equipment Pole
Anemometer Bivane, Cup Anemometers,
Temperature Sensors for Lapse Rate

was instrumented with one anemometer bivane and two temperature sensors for reading turbulence and difference in temperature lapse rate (Figure 82). A humidity sensor and the UV radiation sensor are mounted on the van to complete the package.

Traffic data were gathered with loop detectors on 8 of 12 lanes at the initial sampling site. An experimental radar device was purchased and tested on the 4th Avenue and Santa Monica Freeway site. The detection heads were mounted on the pedestrian overcrossing pointing down and toward oncoming traffic at a 45 degree angle (Figure 83). A signal conditioner was installed in the van to operate these detectors. This device outputs digital signals directly to the multiplexer. Under field usage, this device proved feasible for counting vehicles but speed measurements were unreliable with the present circuit design.

The van was also wired to allow operation of up to 3 sound level meters for studies of freeway generated noise. The data were accessed by the computer and recorded on magnetic tape. Information on this aspect of the study may be found in Referance 10.

Calibration

Instrument calibration is performed by several methods including:

1. Span gases, National Bureau of Standards (NBS) traceable.
2. Permeation tubes.
3. Wet chemistry techniques, EPA recommended methods.
4. Voltage standards, NBS traceable.
5. Wind tunnel testing, pitot tube with inclined manometer.

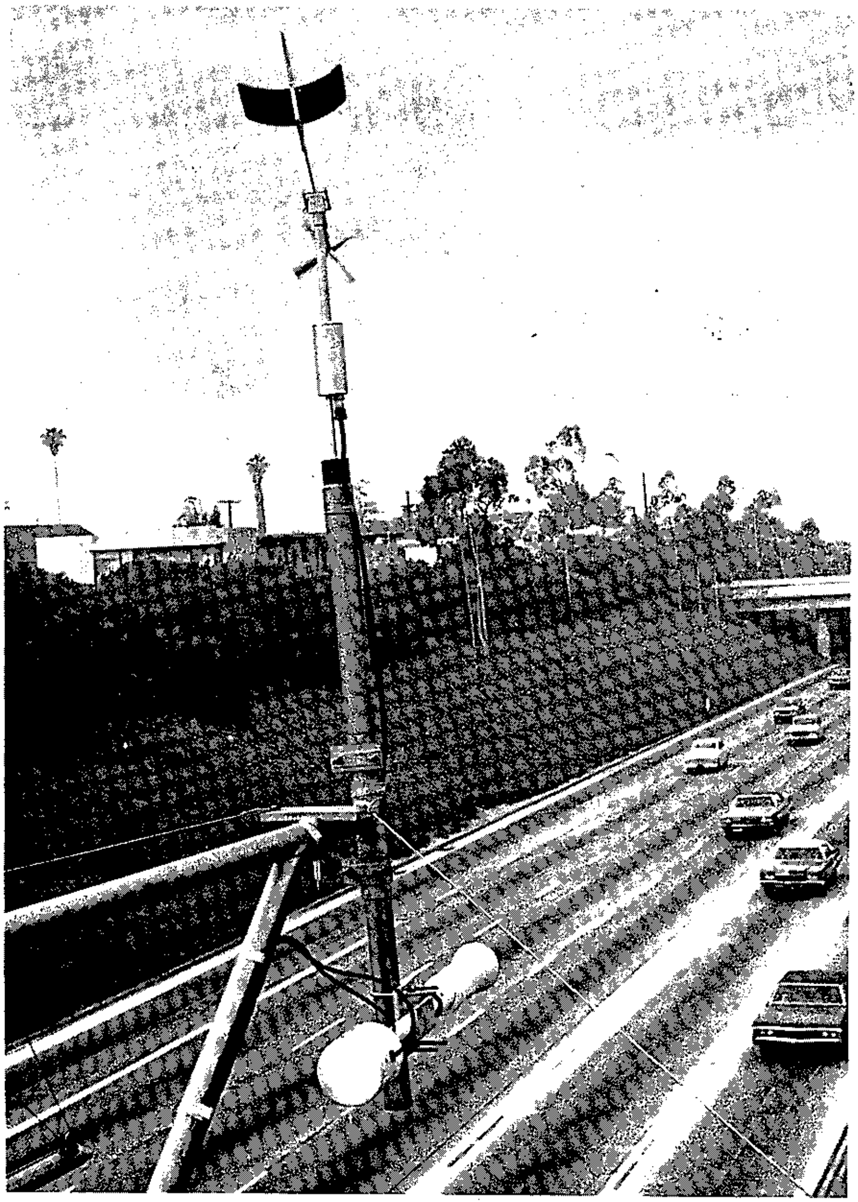


Figure 82 Freeway Section Meteorological Instruments

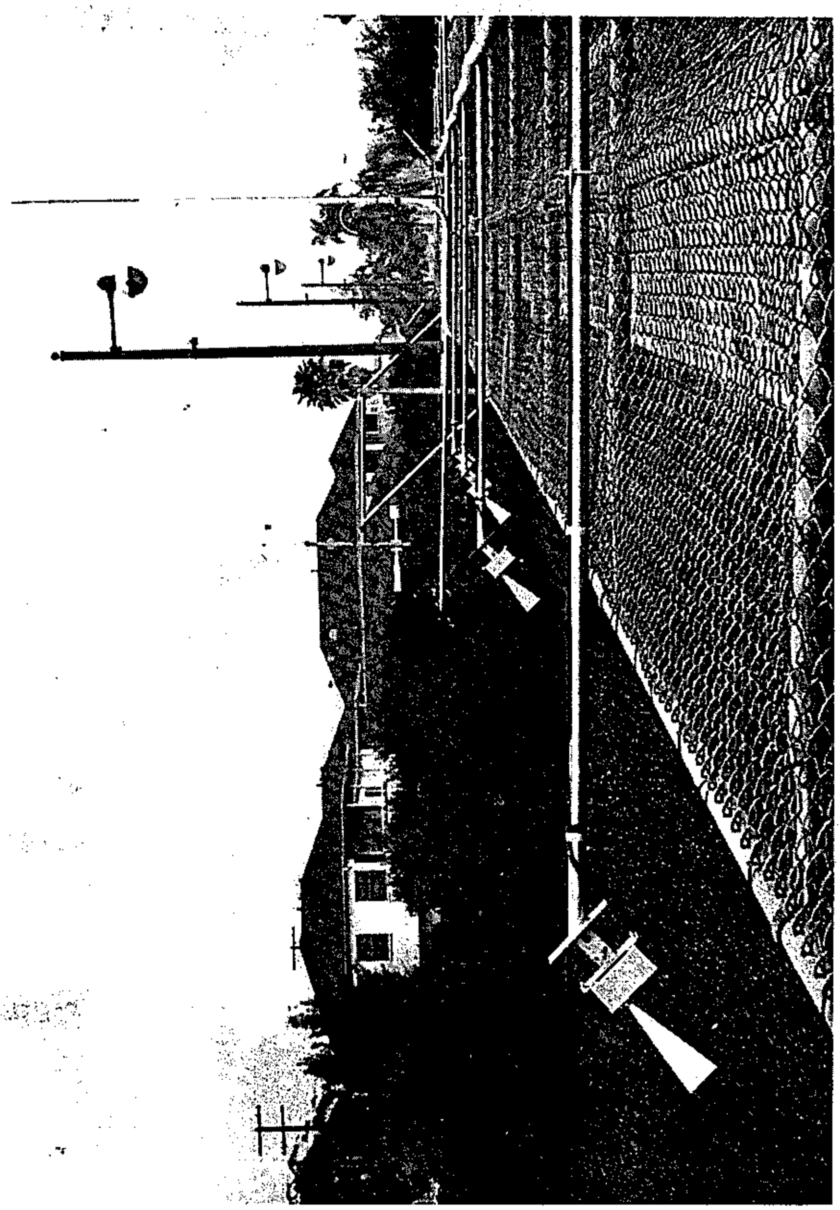


Figure 83 Radar Traffic Sensors On P.O.C.

Span gases, those premixed concentrations of pollutants used to set an up range span point for an analyzer output, were tested and verified by the Air Industrial Hygiene Laboratory, Department of Health. They use NBS supplied cylinders for reference for the NDIR analysis of carbon monoxide (Figure 84).

The oxides of nitrogen analysis is calibrated with span bottles of NO in nitrogen. The instrument uses a converter to change NO_2 to NO for analysis. Therefore, the calibration holds for NO_2 also, but a converter efficiency test is performed to validate NO_2 data produced. These bottles are originally analyzed by the Saltzman wet chemistry method utilizing a NBS traceable photo spectrometer for reagent color change in proportion to concentration.

Hydrocarbon calibration also uses span gas cylinders. In this case, they contain concentrations of methane (CH_4) in synthetic air and also concentrations of propane (C_3H_8) in synthetic air. Both these mixtures are analyzed by laboratory gas chromatographic flame ionization techniques (EPA recommended method). They have been specifically mixed in air to prevent interferences in the ionization of the flame by inducing other inert gases which may chill or alter flame ion balance. The ozone (O_3) analyzer is calibrated by routing O_3 concentrations from an ozone generator to both the Potassium Iodide (KI) wet chemistry analysis and also to the chemiluminescene O_3 analyzer (EPA recommended method). Thus, the analysis is calibrated by the KI method using a NBS traceable photospectrometer for detecting reagent color change in proportion to O_3 in the air sample generated.

The sulfur gas chromatograph is calibrated with a teflon permeation tube containing liquid sulfur dioxide (SO_2) (Figure 85). If a constant temperature and a known constant air or

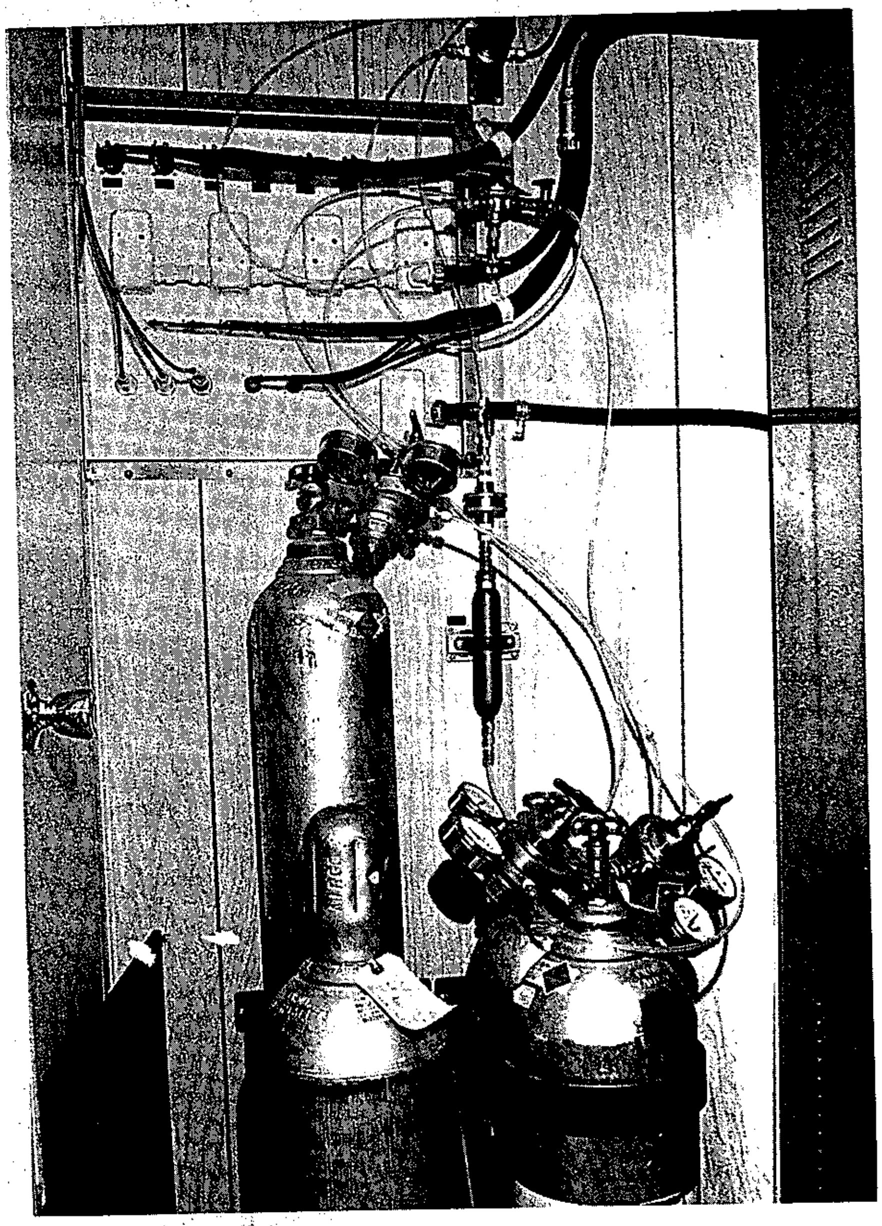


Figure 84 Carbon Monoxide Calibration Gases Nitrogen For Permeation Device

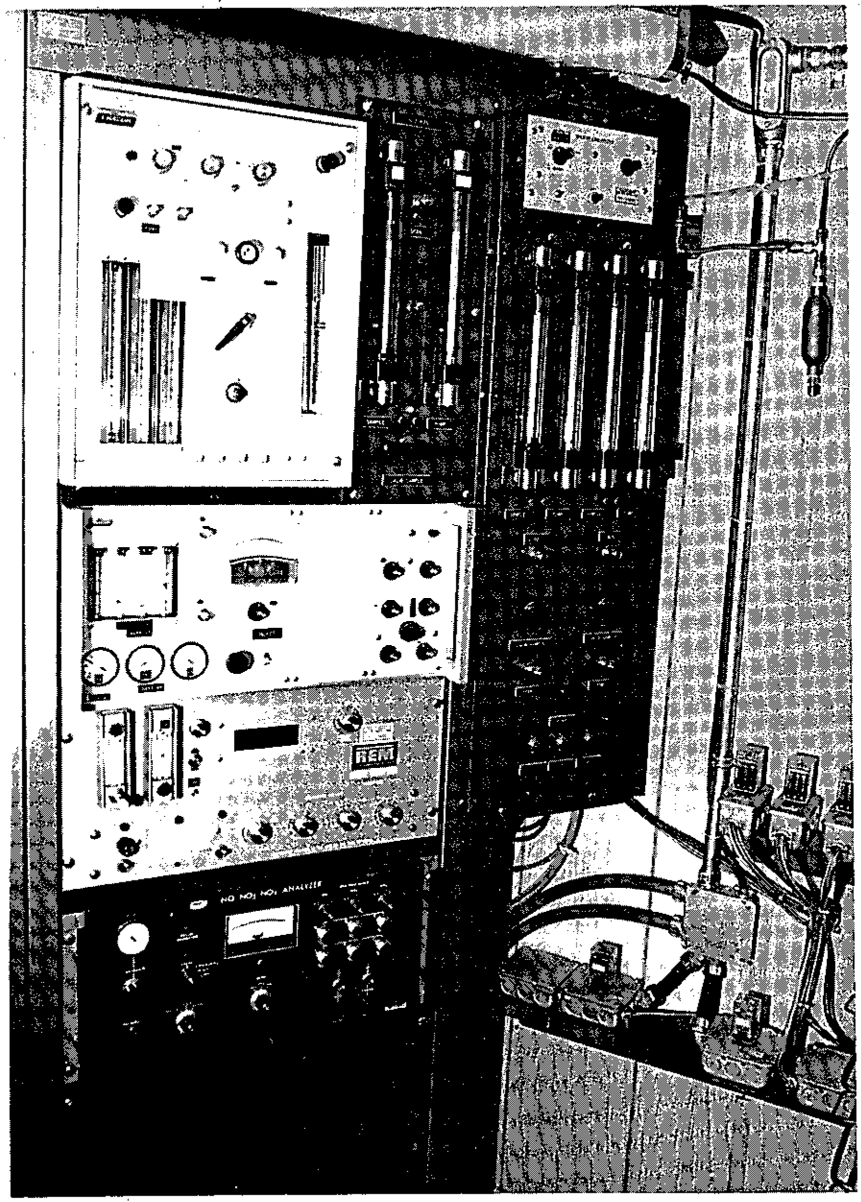


Figure 85 Analyzers For SO_2 and H_2S, O_3, NO_x Permeation Device and Sulfur Linearizer Van Rt. Side Power Control Relays

nitrogen flow rate are applied to the tube, the rate of permeation into the gas stream can be determined by periodic measurement of tube weight loss. This gives a direct physical measurement for primary calibration.

Meteorological instruments are calibrated in the facilities at Translab against NBS traceable basic sensors. For wind speed, a pitot tube and inclined manometer are used with the Translab wind tunnel. Accuracy and linearity of response for wind direction are checked against a degree wheel for the 540° range following the manufacturer's procedure. Temperature sensors are tested against constant temperature baths using NBS traceable thermometers. The humidity sensor was factory calibrated and was retested by the factory during the sampling period.

The radar sensors were calibrated for speed using actual vehicles with previously calibrated speedometers. The count was verified by lane vehicle counts versus indicated totals and by cross verifying the data from the loop system used by District 07 Freeway Operations, Caltrans.

Strip chart recorders and the computer data acquisition devices are tested with a variable DC voltage standard. The basic tests are zero, top scale span, and linearity. In addition, the data acquisition system (multiplexer) regularly scans a constant DC voltage signal and records it on the data tape. These voltage supply devices have NBS traceability through equipment used by the Electronics Section of Translab.

Due to multiplexer reliability problems, an electronic display scope has been added between the multiplexer and the computer data recording. This gives the operator an additional check for system operation and data reliability.

SYSTEM CHECKOUT

The mobile research laboratories present some unique air sampling and analysis problems. The analytical instruments on board are subjected to conditions not usually encountered by permanent monitoring facilities. Sampling through long intake lines and temporary storage of some samples in teflon bags are two examples. As a consequence, it was necessary to carry out a testing program to determine whether these conditions would affect analytical results.

The air monitoring instruments of concern in this program were three Beckman 315B carbon monoxide nondispersive infrared (NDIR) analyzers, a Beckman 6800 gas chromatograph (CO, methane and total hydrocarbon analysis), a Tracor 250-H SO_2 analyzer, a Rem 612 ozone analyzer, and a Bendix 8101B NO-NO_2-NO_x analyzer. Several system variables were studied to determine whether they would affect the responses of the above instruments. These variables included the length of the sample intake line, fluctuation of instrument input voltage, soiling of intake line filters, interior temperature of the research laboratory, sample flow rate through the Beckman CO analyzers, and sample retention time in the teflon bags. Two or three values were chosen for each variable, approximately representing the span of values which would be encountered during actual monitoring operations. Three known concentrations of each pollutant were input to each analyzer either through the sampling lines or after storage in the teflon bags. A statistically-based experimental design was developed which assigned as many as 36 variable combinations (each combination comprising a "data point") to which each instrument could be subjected. Each data point or variable combination resulted in a specific instrument response. Using the Bendix NO-NO_2-NO_x analyzer as an example, when the input voltage was 120 volts, the van temperature 65°F, (18°C) and .75 ppm of NO was input through a 600 foot (183 m) sample line with a clean line filter, the indicated NO concentration was .72 ppm. By use of a stepwise multiple regression analysis computer program, the data were analyzed to determine which of the variables (including instrument response), were significant in estimating the actual gas concentration and which were not. The results of this analysis are summarized in Table 5.

The interference of interior laboratory room temperature was removed by holding the temperature within the laboratory at 75°F (24°C) ± 5°F (2.8°C). The problems with both the ozone and sulfur analyzers were kept to a minimum by sampling only through the shortest line (less than 225 feet (69 m)) and not storing the sample in the teflon bag box system. Details of this system check are discussed in Reference 4.

It must be emphasized that these results may not be valid for NO, NO_2 and NO_x measurements when ambient air is being monitored. The NO, NO_2 and NO_x test gases analyzed in this procedure were interference-free. Significant chemical activity could take place in the sampling lines and bags when ambient air is sampled since this air will often contain interferences such as ozone. These interferences could oxidize NO and decrease the NO/NO_2 ratio during passage through the sampling train.

Table 5

VARIABLES IN THE REGRESSION ANALYSIS SIGNIFICANT IN ESTIMATING ACTUAL POLLUTANT CONCENTRATION

ANALYZER TYPE	INTAKE LINE SYSTEM	BAG STORAGE SYSTEM
Beckman 315-BL- carbon monoxide	Output voltage, van temperature[1]	--
Rem 612 - Ozone	Indicated Concentration[2]	Indicated concentration, retention time in bags.
Beckman 6800 - Total Hydrocarbons, Methane, CO	Indicated concentration (Proportional to output voltage)	Indicated concentration (proportional to output voltage).
Bendix 8101B-NO, NO_2, NO_x	Indicated concentration, satisfactory	Indicated concentration
Tracor 250H- SO_2	Indicated concentration, intake line length	Indicated concentration[3]

1. Temperature can be ignored as a factor if analyzers are exposed to a relatively constant temperature level (i.e., 75°F $\pm$ 5°) (24°C $\pm$ 2.7°).

2. Indicated concentrations of O_3 fluctuated excessively during sampling through the intake line system, a feature which makes this system unreliable for O_3 sampling.

3. Conclusion based on limited test data.

AUTOMATED DATA ACQUISITION AND PROCESSING

To best characterize air quality, meteorological and traffic conditions, data must be collected on as nearly a continuous basis as possible. The configuration of the air quality instrumentation in the mobile research laboratories does not permit completely continuous sampling. However, the pollutant sampling scheme is designed to adequately represent averages taken over a one hour period.

Carbon monoxide is monitored in two manners. The NDIR system is designed so that each probe is monitored for one minute out of every five minutes during the hour. This provides 12 samples evenly spaced over the hour. To obtain the samples, the valves are switched by a minicomputer, the NDIR analyzer is read by the minicomputer, and the values are stored on tape. The other carbon monoxide monitoring instrument is incorporated in the hydrocarbon analyzer and bag box system. It measures air samples obtained by filling nine teflon bags during the first 15 minutes of every hour. Bag number 1 is analyzed from the 16th minute through the 20th minute, bag number 2 from the 21st minute through the 25th minute, and so on. Bag number 9 is always analyzed during the final 5 minute period of each hour. The 5 minute period is the time required for the hydrocarbon analyzer to measure carbon monoxide, total hydrocarbons, and methane. The total cycle requires 60 minutes to complete. It is repeated hourly from 6:00 a.m. to 8:00 p.m. All of the valve switching required to fill the bags, analyze the samples within the bags and then purge the bags is handled automatically by the computer. The data obtained from the bag box hydrocarbon analyzer and NO/NO_2NO_x analyzer are automatically stored on magnetic tape, as in the NDIR system.

Measurements of ozone, H_2S and SO_2 are made at one point only, due to sampling train interferences. The ozone, H_2S and SO_2 cannot be collected through a 600 foot (183 m) line at a rate of 1 litre/minute without significant chemical degradation occurring. Therefore, they are continuously monitored using only one probe located near the mobile laboratory.

Meteorological data are also obtained on a continuous basis at the site. The number of readings taken each hour is as follows:

Variable	Sample/Hours
Three dimensional wind	36000
Horizontal wind speed	36000
Humidity	60
Incoming ultraviolet radiation	60
Temperature (T)	60
Temperature lapse rate (ΔT)	60

These data or their 10 second averages in the case of wind direction and speed are automatically stored on magnetic tape by the minicomputer. Standard deviations for many of the parameters are also calculated and stored on tape.

Figure 86 illustrates the data collection scheme. The output voltages from the various sensors are fed into a multiplexer for processing. They are then accumulated in the minicomputer and stored on magnetic tape. Incorporated in this scheme is a series of quality assurance control operations. A cathode ray tube monitors all channels feeding into the minicomputer as a check on the data acquisition system. At the end of the day's sampling period (8:00 p.m.) the magnetic tape is reread by the minicomputer. Three hourly summaries are obtained at this time to verify the operation of the data collection system. A system of strip chart recorders to monitor amperage is also provided.

This serves as a check on the minicomputer data acquisition system, and as a backup system when the automated system is not working properly.

The daily magnetic tapes are mailed from the sampling site to Translab in Sacramento for further processing. Each of the tapes is then run through a series of IBM 370 computer programs to check for errors and to update the master data file, Figure 87. The SAROAD master file system (storage and retrieval of aerometric data) and the AQDHS (air quality data handling system) of the Environmental Protection Agency are the systems used to file the data. Codes and related information for each parameter placed in the AQDHS file from the project are shown on Table 6.

These master file tapes, once complete for any one site, are then run through the AQDHS report writer. This provides monthly tables of the hourly averages of each of the variables requested. Once the data have been reviewed, the master file may be interfaced with other programs to evaluate predictive models, check for redundant probes or generate statistical analyses (see Figure 88). These analyses are detailed in the sections on "Typical Gaseous Pollutant Analyses" and "Typical Atmospheric Particulate Analysis".

Table 6

A Q D H S PARAMETER CODES

Description	Units	Approx. Range	No. of Readings Per Hour	Parameter Code	Method Code	No. of Probes
Carbon Monoxide (NDIR)	PPM	0-50	12	42101	11	15
Carbon Monoxide Maximum	PPM	0-50	1	70000	11	15
Carbon Monoxide Minimum	PPM	0-50	1	70001	11	15
Carbon Monoxide Standard Deviation	PPM	0-10	1	70002	11	15
Total Hydrocarbons	PPM	1-25	15 Min. Bag Sample	43101	11	9
Carbon Monoxide (Gas Chromatograph)	PPM	0-50	"	42101	91	9
Methane	PPM	0-5	"	43201	11	9
Reactive Hydrocarbons	PPM	0-20	"	77300	11	9
Nitric Oxide	PPM	0-2	"	42601	11	9
Nitrogen Dioxide	PPM	0-1	"	42602	11	9
Oxides of Nitrogen	PPM	0-2	"	42603	11	9
Sulfur Dioxide	PPM	0-1	3600	42401	11	1
Sulfur Dioxide Maximum	PPM	0-1	1	77000	11	1
Sulfur Dioxide Minimum	PPM	0-1	1	77010	11	1

Table 6 (Continued)

Description	Units	Approx. Range	No. of Readings Per Hour	Parameter Code	Method Code	No. of Probes
Sulfur Dioxide Standard Deviation	PPM	0-1	1	77020	11	1
Hydrogen Sulfide	PPM	0-1	3600	42402	11	1
Hydrogen Sulfide Maximum	PPM	0-1	1	77100	11	1
Hydrogen Sulfide Minimum	PPM	0-1	1	77110	11	1
Hydrogen Sulfide Standard Deviation	PPM	0-1	1	77120	11	1
Ozone	PPM	0-1	3600	44201	11	1
Ozone Maximum	PPM	0-1	1	77200	11	1
Ozone Minimum	PPM	0-1	1	77210	11	1
Ozone Standard Deviation	PPM	0-1	1	77220	11	1
Horizontal Wind Speed	M/S	0-10	36000	75000	11	2
Vertical Wind Speed	M/S	0-1	36000	75100	11	2
Horizontal Wind Angle Standard Deviation (10 Sec.)	Radians	0-2	360	75200	60	2
Horizontal Wind Angle Standard Deviation (1 minute)	Radians	0-2	60	75200	61	2
Horizontal Wind Angle Standard Deviation (5 minutes)	Radians	0-2	12	75200	62	2

Table 6 (Continued)

Description	Units	Approx. Range	No. of Readings Per Hour	Parameter Code	Method Code	No. of Probes
Horizontal Wind Angle Standard Deviation (10 minutes)	Radians	0-2	6	75200	63	2
Horizontal Wind Angle Standard Deviation (30 minutes)	Radians	0-2	2	75200	64	2
Horizontal Wind Angle Standard Deviation (60 minutes)	Radians	0-2	1	75200	65	2
Vertical Wind Angle Standard Deviation	Radians	0-1	1	75300	11	2
Horizontal Wind Angle	Radians	1-5	36000	75400	11	2
Vertical Wind Angle	Radians	0-1	36000	75500	11	2
Cup Anemometer Wind Speeds	M/S	0-10	36000	76700	11	2
Cup Wind Speed Standard Deviation	M/S	0-1	60	75650	61	2
Cup Wind Speeds Standard Deviation	M/S	0-1	6	75650	63	2
Cup Wind Speed Standard Deviation	M/S	0-2	1	75650	65	2
Relative Humidity	%	30-105	60	75700	11	1
Solar Radiation	$m/W/CM^2$	20-60	60	75800	11	1

Table 6 (Continued)

Description	Units	Approx. Range	No. of Readings Per Hour	Parameter Code	Method Code	No. of Probes
Temperature	°C	15-27	60	75900	11	2
Temperature Difference	°C	0-1	60	76000	11	2
Temperature Standard Deviation	°C	0-3	1	76100	11	2
Temperature Difference Standard Deviation	°C	0-1	1	76200	11	2
Traffic Volume	10/Veh/Hr	10-1000	--	76300	11	2
Average Speed	MPH	5-70	--	76400	11	2
Traffic Volume Standard Deviation	10 Veh/Hr		--	76500	11	2
Speed Standard Deviation	MPH		--	76600	11	2
Barametric Pressure	----	----	--	76700	11	1
Richardson Number	Dimen-sionless	(-1)-1	Calculated from hourly averages	76800	11	1
Wind Difference	M/S	0-1	"	76900	11	1
Bulk Richardson	Dimen-sionless	(-1)-1	"	76850	11	1
Ceiling Height	100 x ft	0-200	1	76870	11	1
Sky Code	Dimen-sionless	0-9	1	76880	11	1

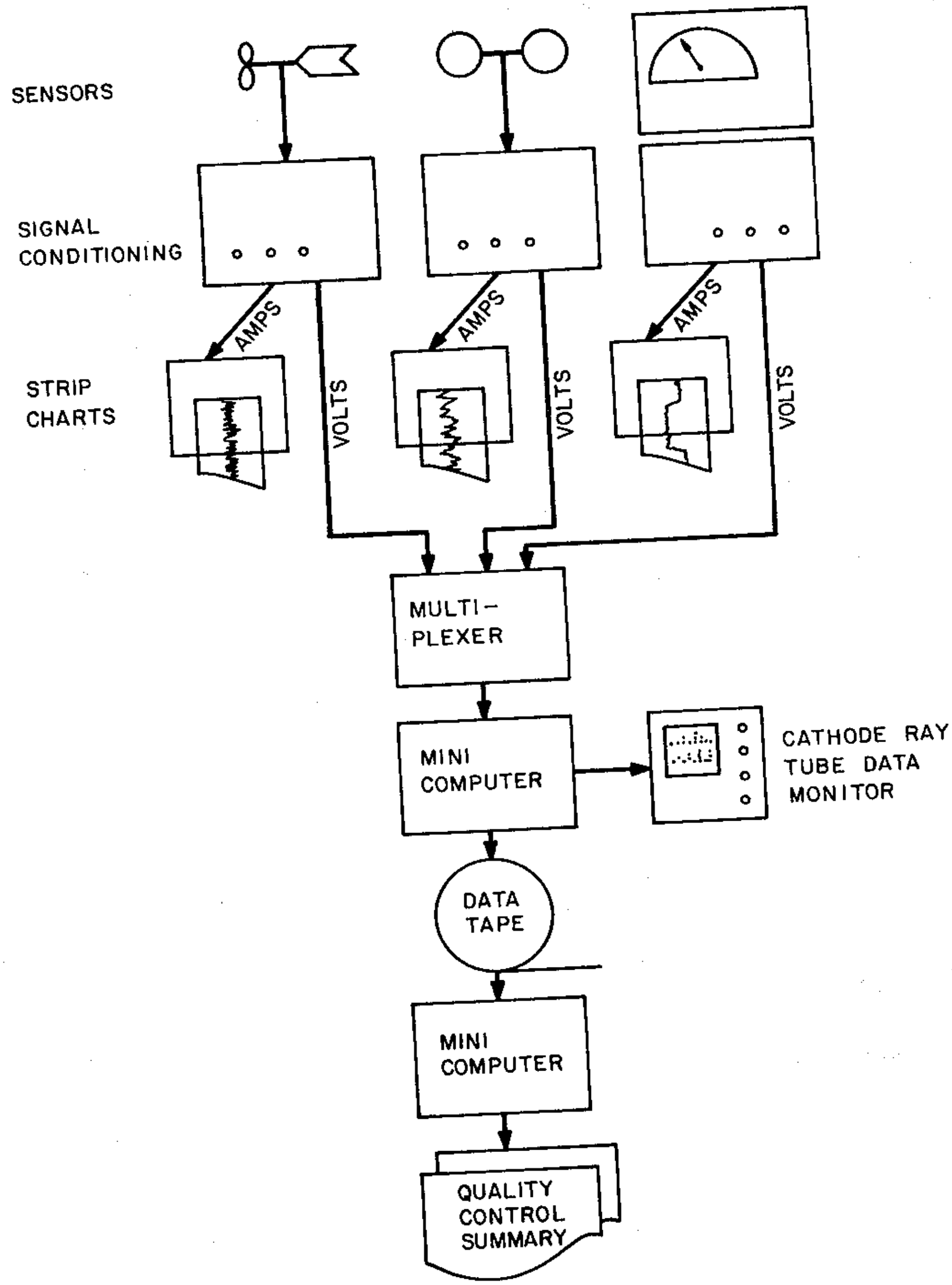


FIG. 86 DATA COLLECTION SYSTEM FLOW CHART

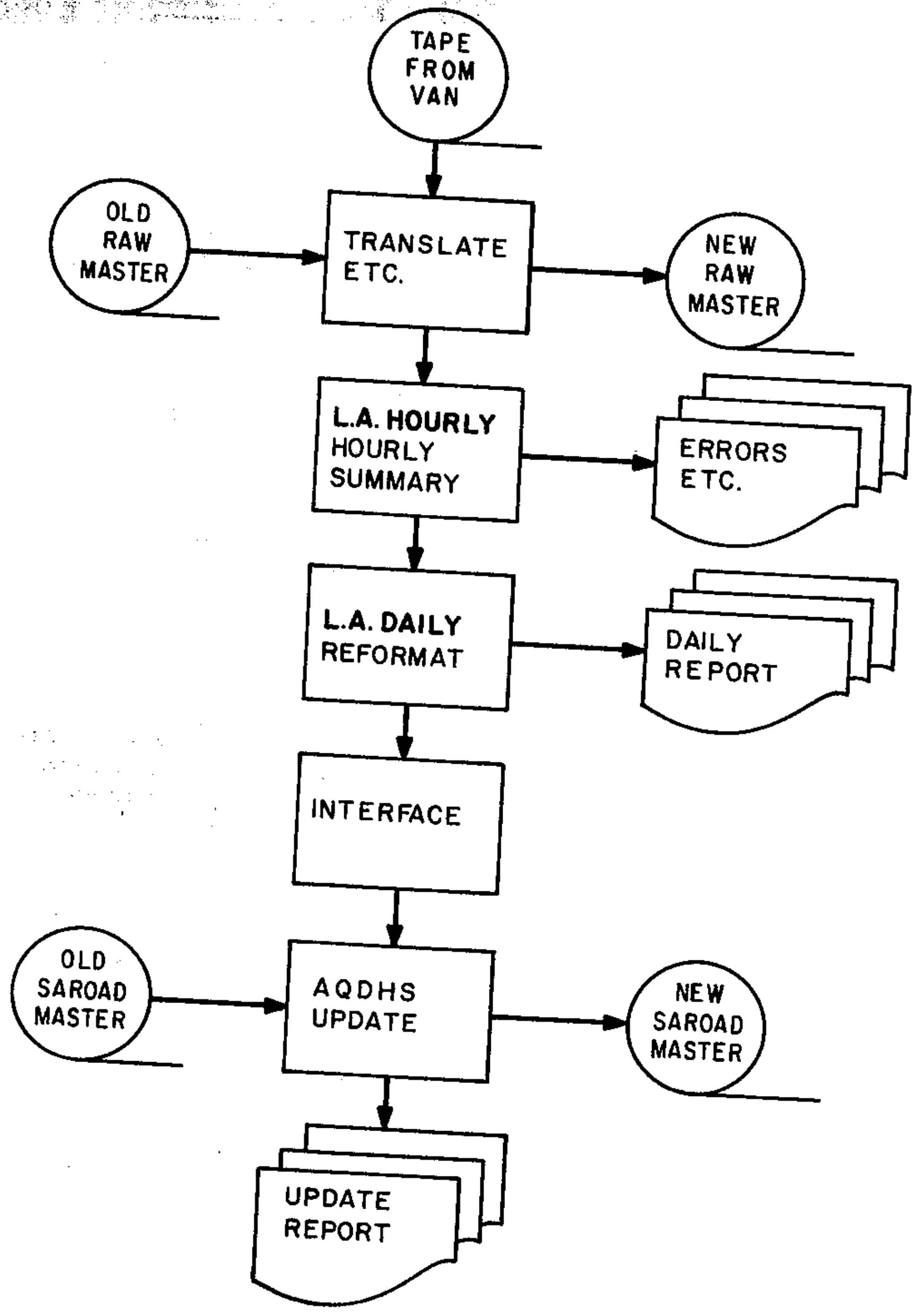


FIG. 87 FLOW CHART FOR UPDATING MASTER FILE

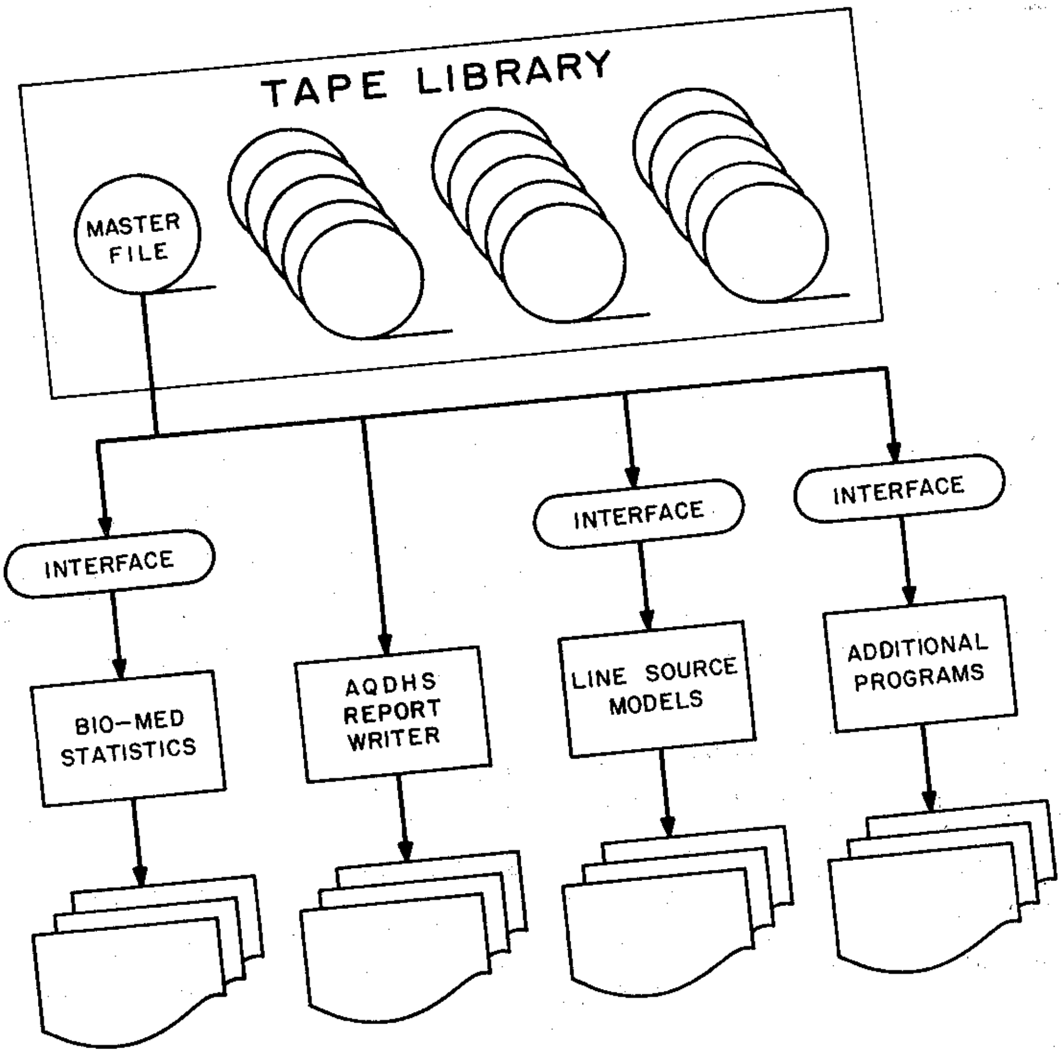


FIG. 88 REPORT GENERATORS FOR AQDHS MASTER FILE

QUALITY CONTROL

In an automated data collection system, quality control procedures are necessary to insure that reliable data is being collected. The field personnel who operate the mobile laboratories examine all the strip charts on an hourly basis. They check for rapid deviations in the parameters measured. They also check to see if the values fall within a reasonable range (see Table 7).

As can be seen from Figure 86, the strip charts do not check the voltage side of the data acquisition system. To check this, a cathode ray tube is used. This will determine whether the system is operating properly from the signal conditioning unit up to entrance into the minicomputer. Ranges of values can also be observed on a cathode ray tube.

Periodically, the field personnel observe the meter indications of the air quality instrumentation in the bag box system, along with wind speed, wind direction, and temperature lapse rate. These observations are compared to strip chart values, values summarized on the minicomputer, and later to values on the SAROAD data system master file.

At the end of the sampling day, the daily magnetic tape is analyzed by the minicomputer. Hourly averages of 0700-0800, 1200-1300 and 1700-1800 hours are obtained. These hourly averages are also checked for range of values. The standard error is examined in order to evaluate reasonableness of the variability.

The field personnel fill out a daily log sheet detailing any problems which may have arisen during the day. They also record "down" times for any of the sampling systems in the laboratory. These diary sheets are used later to remove the corresponding data from the master file.

TABLE 7

ESTIMATED RANGES OF POLLUTANT CONCENTRATIONS IN PPM (1 Hour Averaging Time)

Pollutant	Upwind	In Section	Downwind
CO	1-10	10-50	3-20
THC	2-8	5-15	4-10
Methane	0.5-3	1-5	0.5-5
NO_x	0.1-1.0	1-4	0.1-2
NO	0.05-0.5	1-4	0.05-1.0
NO_2	0.05-0.5	0.1-1.0	0.05-1.0
O_3	0.02-0.20	-----	0.02-0.20
H_2S and SO_2	Trace	-----	Trace

Note: If high CO, HC, NO_x concentrations are measured, check the measured values upwind, downwind, and in-section. May be an episode.

These values are "ballpark" estimates based on other studies with mini-vans and local APCD stations. However, this should serve as a guide for the routine check-out of the system.

TYPICAL GASEOUS POLLUTANT ANALYSIS

Another intention of this study was to characterize temporal and spatial distributions of atmospheric pollutants adjacent to highways, and to evaluate microscale models which predict air pollution levels adjacent to highways. In order to collect gaseous pollutant data for this purpose, the probe layouts for the various field sites were chosen as illustrated in the site selection section. The probes with the asterisk (numbers 1 through 9) are the probes where data from the bag box and NDIR system were obtained. Some of these probes also were used to collect ozone, H_2S and SO_2 data. At the Santa Monica Freeway site, the bag box probes were used in a vertical array from November 1, 1973 until June 12, 1974, Figure 12. They were placed in a horizontal array from June 13, 1974 until the completion of the summer sampling, July 19, 1974, Figure 13. At Sites 6 through 8, the probes were located as indicated in Figures 41 through 51 and were not modified. In order to compare the concentration gradients for different pollutants, concentrations were normalized to a value of unity for the lowest probe. Table 7 shows actual concentrations and normalized values for a typical morning hour at the Santa Monica Freeway site. The actual concentrations are presented graphically in Figures 89 and 90. Figure 91 is a plot of the normalized values. The following conclusions were drawn from this kind of analysis.

1. CO, THC and NO_x tend to have the same vertical dispersion characteristics.

    a. Uniform within cut section
    b. Large gradient above cut (except THC)
    c. All source-oriented in section

2. NO_2 concentrations are low near source.

3. NO concentrations are high on the roadway because of emissions from vehicles.

4. Away from roadway NO_2 concentrations tend to increase slightly.

5. Vertical concentration gradients from the 4 foot (1.2 m) to 60 foot (18.2 m) probe locations for CO and NO_x are similar.

6. Concentration gradients for CO and NO_x are greater than for THC.

7. Lapse rates over the highway tend to be more unstable than over areas adjacent to roadways. This may be caused by:

   a. Different thermal conductivities of concrete surface versus land use.

   b. Exhaust gas temperatures (230°F (110°C)) are warmer than the environment.

8. Ambient levels of CO are approached about 300 feet (91 m) from the edge of pavement in urban areas for single and two-story dwellings for stable atmospheric conditions.

9. Ambient levels of CO for flat open rural areas are approached at distances greater than 400 feet (122 m) from the edge of the pavement for stable atmospheric conditions.

TABLE 8

NORMALIZED DATA - BAG BOX SAMPLES -
SANTA MONICA FREEWAY AT 4TH AVENUE
P.O.C. (SITE 1) MAY 15, 1974 0700-0800

Height Z'ft.	CO ppm	CO Nor.	THC ppm	THC Nor.	NO_x ppm	NO_x Nor.
4	16.0	1.00	8.5	1.00	1.70	1.00
12	12.0	0.75	8.0	0.94	1.32	0.78
20	10.0	0.63	7.5	0.88	1.12	0.66
42	6.0	0.38	6.0	0.71	0.60	0.35
60	4.0	0.25	6.0	0.71	0.32	0.19

All data are instantaneous 15 minute averaging times.

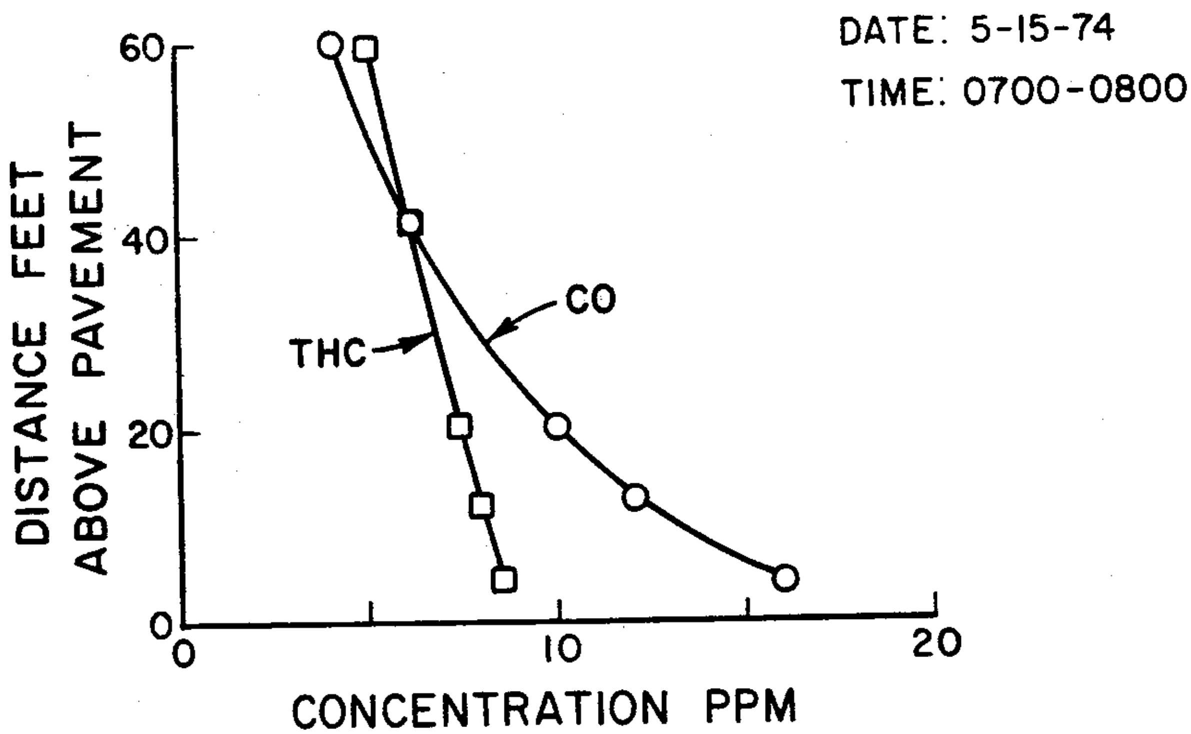


FIG. 89 SANTA MONICA FREEWAY @ 4TH AVE. P.O.C. (SITE I)
IN SECTION
VERTICAL DISPERSION AT MEDIAN
CO/THC - BAG BOX
15 MIN. AVERAGING TIME

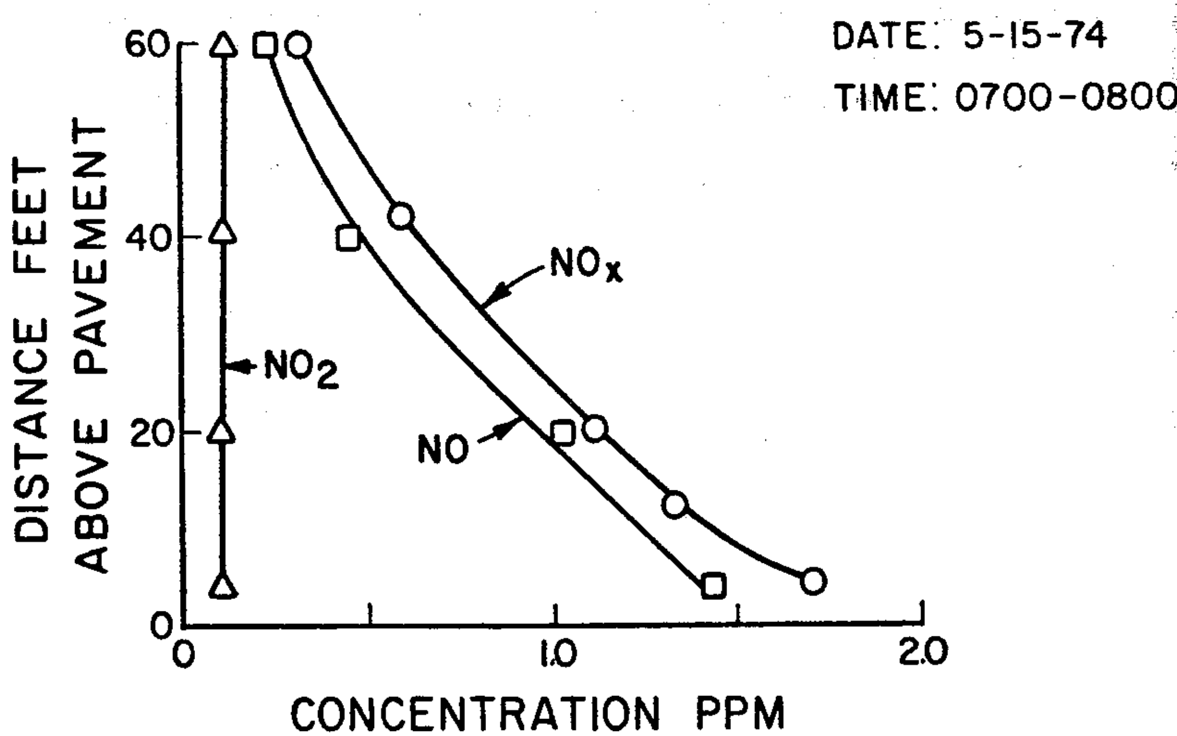


FIG. 90 SANTA MONICA FREEWAY @ 4TH AVE. P.O.C. (SITE I)
IN SECTION
VERTICAL DISPERSION AT MEDIAN
$NO/NO_2/NO_x$ BAG BOX
15 MIN AVERAGING TIME

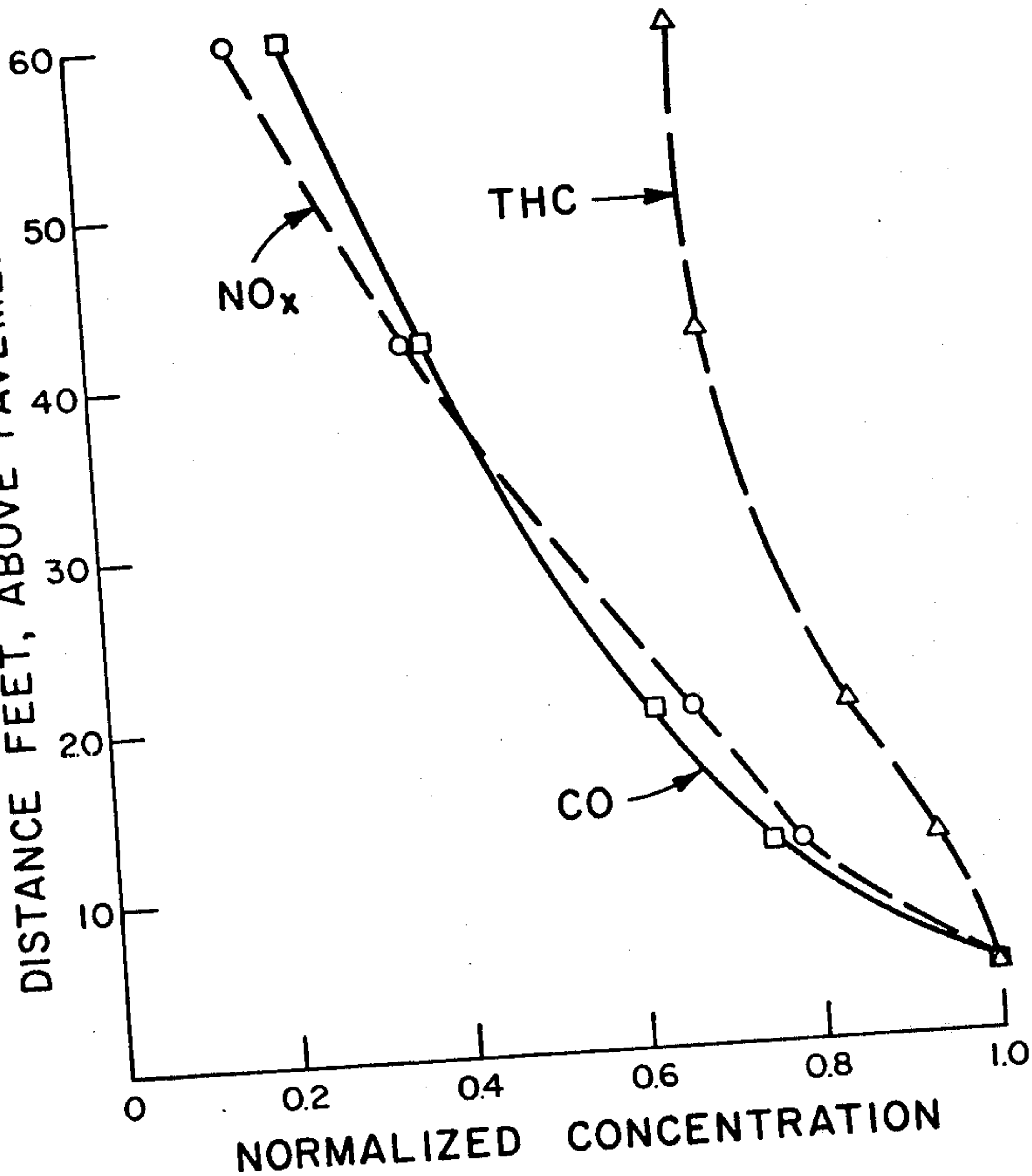


FIG. 91 VERTICAL DISPERSION MEDIAN SANTA MONICA FREEWAY @ 4TH AVE -- (SITE I) MAY 15, 1974 - 0700-0800

TYPICAL ATMOSPHERIC PARTICULATE ANALYSIS

In addition to characterizing the distribution of gaseous pollutants adjacent to freeways, a preliminary study of particulate concentrations adjacent to freeways was undertaken.

The purposes of the sampling were to:

1. Determine the temporal and spatial distributions of both total suspended particulates and lead adjacent to roadways of different highway geometrics.

2. Determine the dispersion characteristics of total suspended particulates and lead downwind from a highway, as a function of meteorology and traffic densities.

3. Determine the particle size distribution of highway generated particulates as a function of distance from the source and meteorology.

4. Evaluate the practicality of using particulate models to estimate highway impact particulate levels adjacent to freeways.

High-volume air samplers (Figure 92) were used to collect total suspended particulates and determine atmospheric lead levels. Glass fiber filters were used to collect the sample. The filters were conditioned at 70°F (21°C) and 50% relative humidity both before and after sampling. The conditioned filters were weighed before and after sampling with a balance accurate to 0.0001 grams. The amount of lead collected on the filters was determined by Atomic Absorption Spectrophotometry. These values were divided by the volume of air drawn through the filter during the sampling period to obtain the concentrations in micrograms/cubic meter.

Figure 92 View of Lundgren Impactor and Hi Vol at Field Sampling Site

The samples were collected for 2 hour periods. This was determined to be about the minimum time duration consistent with the precision of the high-volume air sampler. This was determined by running several hi-vols side-by-side. One was run for 12 hours continuously, one for 4 hours, one for 6 hours, and one for a two hour time period. The average of six 2-hour time periods was about the same as the 12 hour sample. By using a 2 hour averaging time one is allowed to characterize the particulate concentrations as meteorology and traffic volumes change throughout a given day.

Lundgren Impactor data were collected simultaneously with most of the hi-vol data, as shown in Table 8. The Lundgren Impactor (Figure 92) provides particle size distribution and elemental sulfur, but does not provide chemical composition. The Lundgren samples are analyzed using Ion Excited X-Ray Emission(8). This is performed at the Crocker Nuclear Laboratory at the University of California at Davis.

TABLE 9

PROBE LOCATIONS OF HI-VOLS AND LUNDGREN IMPACTORS

Site No.	Probe No.	Hi-Vol	Lundgren
1	5	X	X
1	6	X	X
1	10	X	X
1	9	X	X
1	1	X	X
6	6	X	X
6	13		X
6	2	X	X
6	8		
8	9	X	X
8	near 3	X	X
8	8	X	X
8	6	X	X
8	15	X	X

Almost all of the lead collected by the Lundgren Impactor on this project has been found to be less than 5 microns in diameter. If this is the case, the lead may be assumed to have a low gravitational settling velocity while in the vincinity of the roadway and the lead may be modeled as if it were a gas. Another study (9), apparently observing larger size particulates, reports the corridor along a roadway that would be expected to have high lead concentrations would be limited to approximately 250 ft (76.2 m) from the roadway. It also states, however, that the smaller particulates, less than 3 microns, tend to stay aloft until scavenged by rainfall or until impaction occurs. Modeling lead as a gas is a very simplified approach. However, initial comparisons indicate that it is at least within an order of magnitude of the actual field value.

Typical 2 hour lead concentrations are plotted in Figure 93 for the depressed section at Site 1 for varying distances from the source. As can be seen from the figure, lead concentrations are higher within the depressed section. The values at the downwind top of cut are only slightly higher than the value at 300 feet (91 m) upwind and 300 feet (91 m) downwind. Note also that the upwind value is usually approached within 300 feet (91 m) downwind.

The lead values obtained from the Lundgren Impactor were compared to those obtained using the high-volume sampler. The hi-vol is currently the accepted standard for measuring both total suspended particulates and atmospheric lead. It appears that the two instruments correlate fairly well at locations removed from the source, but do not correlate well closer to the source. This may be due to possible differences in ranges of particle size measured by the two instruments.

Further sampling and analyses of particulate levels and dispersion is needed for development of dispersion models.

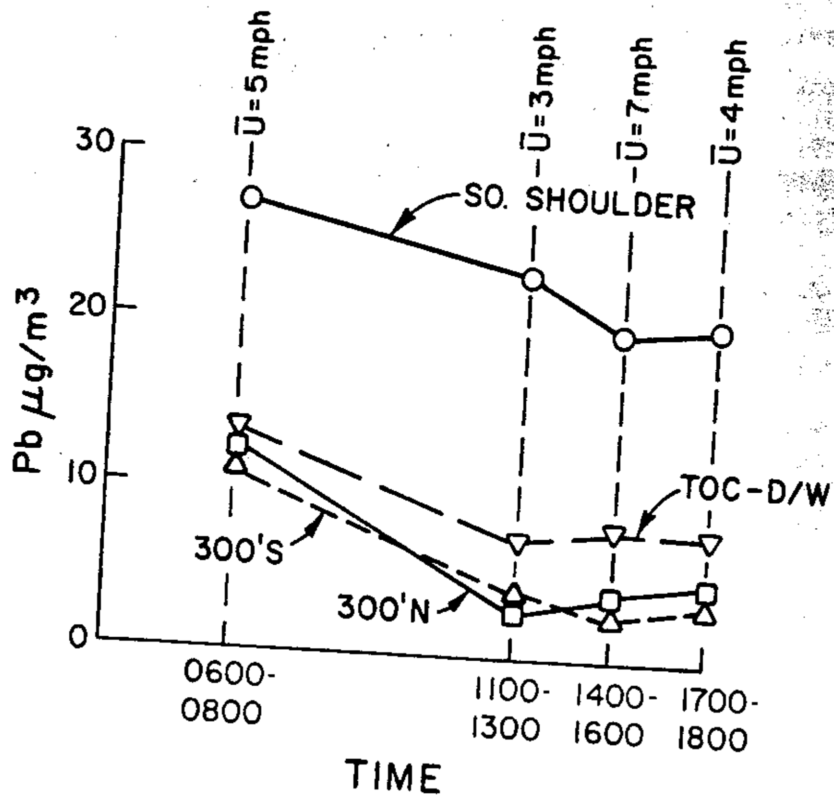


FIG. 93 LEAD STUDY - TEMPORAL DISTRIBUTION SANTA MONICA @ 4TH AVE., P.O.C. (SITE I)

DATE: 1-23-74
HOURS: 0600-1900

$3 \leq \bar{U} \leq 7$ MPH
$12,000 \leq VPH \leq 18,000$

REFERENCES

1. Ranzieri, A. J., and Bemis, G. R., "Air Pollution and Roadway Location, Design and Operation -- Preliminary Bag Study for Carbon Monoxide", California Department of Transportation, Transportation Laboratory, CA-DOT-TL-7080-2-75-15, May, 1975, also FHWA report FHWA-RD-76-141, September 1976.

2. Beaton, J. L., Skog, J. B., Shirley, E. C., and Ranzieri, A. J., California Department of Transportation, Transportation Laboratory. April 1972.

   a. Meteorology and Its Influence on the Dispersion of Pollutants from Highway Line Sources (FHWA-RD-72-33).

   b. Motor Vehicle Emission Factors for Estimates of Highway Impact on Air Quality (Currently being revised). (FHWA-RD-72-34)

   c. Traffic Information Requirements for Estimates of Highway Impact on Air Quality. (FHWA-RD-72-35)

   d. Mathematical Approach to Estimating Highway Impact on Air Quality. (FHWA-RD-72-36)

   e. Analysis of Ambient Air Quality for Highway Projects. (FHWA-RD-72-38)

   f. A Method for Analyzing and Reporting Highway Impact on Air Quality. (FHWA-RD-72-39)

3. Ward, C. E., and Ranzieri, A. J., "CALINE 2 - An Improved Microscale Model for the Dispersion of Air Pollutants from a Line Source", California Department of Transportation, Transportation Laboratory. (FHWA-RD-77-74) June 1977.

4. Peter, R. R., and Ranzieri, A. J., "Air Pollution and Roadway Location, Design and Operation -- Variables Affecting Air Quality Instrument Operation", California Department of Transportation, Transportation Laboratory. FHWA-CAL-TL-7080-77-15, July. 1977, also FHWA Report FHWA-RD-77-77.

5. Winter, W. A., and Farrockhrooz, M., "Mini-Computer Software Data Acquisition and Process Control System for Air Pollution Monitoring", California Department of Transportation, Transportation Laboratory. CA-DOT-TL-7080-3-76-39, May, 1976, also FHWA report FHWA-RD-76-145.

6. Lissaman, P. B. S., "A Simple Unsteady Concentration Model Explicitly Incorporating Ground Roughness and Heat Flux", AeroVironment Inc., 1973.

7. Kirsch, J. W., and Mason, B. F., "EXPLOR, Volume I: Theory and Validation", Systems Science and Software (S^3), La Jolla, California, January, 1974.

8. Cahill, T. A., and Feeney, P. G., "Contribution of Freeway Traffic to Airborne Particulate Matter", Crocker Nuclear Laboratory, University of California, Davis, March, 1974.

9. Daines, Robert H., Motto, Harry, Chilko, Daniel M., "Atmospheric Lead: Its Relationship to Traffic Volume and Proximity to Highways", Environmental Science and Technology, April, 1970.

10. Winter, W. A., and Nakao, D. K., "Noise Pollution and Roadway Location, Design and Operation", California Department of Transportation, Transportation Laboratory, CA-DOT-TL-7149-1-76-53 (FHWA-RD-77-73), June, 1977.

APPENDIX A

Members of Research Advisory Committee:

J. G. Bell
Freeway Operations, District 07
California Department of Transportation
Los Angeles, California 90054

David L. Calkins
Regional Air Pollution Control Director
Environmental Protection Agency, Region IX
San Francisco, California 94111

A. C. Estep
Chief, Office of Local Assistance
California Department of Transportation
Sacramento, California 95807

L. R. Gillis, Retired
Depty State Highway Engineer
California Department of Transportation
Sacramento, California 95807

D. H. Henry
Traffic Branch
California Department of Transportation
Sacramento, California 95807

George A. Hill, Chairman
Chief, Office of Transportation Laboratory
California Department of Transportation
Sacramento, California 95819

Ken E. Jones
Office of Research
Environmental Design and Control Division
U. S. Department of Transportation
Federal Highway Administration
Washington, D. C. 20590

Dr. Howard Jongedyk
Office of Research
Environmental Design and Control Division
U. S. Department of Transportation
Federal Highway Administration
Washington, D. C. 20590

William Lake
U. S. Department of Transportation
Federal Highway Administration, Region Seven
Sacramento, California 95809

Dr. Leonard O. Myrup
Division of Environmental Studies
University of California
Davis, California 95616

Andrew E. O'Keefe
Chief, Air Quality Measurements Methods Branch
Environmental Protection Agency
Research Triangle Park, North Carolina 27711

James R. Taylor
Los Angeles County Air Pollution Control District
Los Angeles, California 90013

Harmon Wong-Woo
California Air Resources Board
Sacramento, California 95814

APPENDIX B

LOS ANGELES DATA BASE USERS GUIDE

Preface

This data base was accumulated using the Caltrans air pollution monitoring research van in the Los Angeles area during 1974-75. Four locations were monitored. "Site 1" and "Site 2" represent the same location with different probe configurations. The location is the Santa Monica Freeway (Route I-10) at the 4th Avenue Pedestrian Overcrossing, a depressed section. "Site 3" is on the San Diego Freeway (Route I-405) at 134th Street, a fill area. "Site 4" was included to study the pollutant levels adjacent to a frequently used on ramp. The investigators were not satisfied with the collected data and the data are not considered a viable portion of the Los Angeles data base. It is recommended that data base users ignore them. The Site 4 location is the San Diego Freeway along the 116th Street on-ramp. "Site 5" is on the Santa Ana Freeway (Route I-5) at the South Orange Overcrossing near El Toro, an at-grade location.

The site numbers above differ from the site numbers in the report. The latter refers to "Site 1" as Site 1 and also "Site 2" as Site 1; "Site 3" as Site 6, "Site 4" as Site 7, and "Site 5" as Site 8. The site numbers used in this user's guide are those site numbers assigned for use in the Air Quality Data Handling System file, whereas the site numbers in the report body refer to all sites considered during the project planning phase without regard to whatever data each site may have generated for historic filing. For consistency, the AQDHS site numbers will be used throughout Appendix B, the Los Angeles data base users guide.

The main report contains a detailed description of the sampling equipment, site selection, data gathering and storage methods, and related air quality investigations.

Data Base Preparation

Included in the data base are: (1) raw data tapes, unedited, which contain all data taken for each day of sampling on the project; (2) raw data tapes, edited, which have been purged of information found to be faulty during our editing process; (3) complete copies of the Air Quality Data Handling System (AQDHS or SAROAD) file which resulted from our work; (4) traffic data tapes for the sampling vicinities, which were taken from information gathered in our Surveillance Loop Project; and (5) selected samples of traffic counts of heavy duty vehicles for use in extrapolating diesel - gasoline splits.

The first step in the editing process was to average the raw data on an hourly basis and print out the results using the LA HOURLY program and Program Eng 136. These data were checked to insure correct header information, and all times have been corrected to Pacific Standard time. These hourly printouts were then inspected for bad data readings. Data recorded during periods shown as "down" on the operator's logs were stricken, as were data determined by the editors to be outside reasonable limits. The months, days, and hours of bad data were entered into an editing program and these data were purged. Finally, the edited data were entered into our AQDHS-1 data file using Program LA DAILY. Figure 1 is a flow chart of data preparation and editing starting with the tapes generated in the research van, through programs LA HOURLY and LA DAILY to the AQDHS-1 file.

In preparing the data base, three computer programs were written. The first program checked and corrected header information and changed all data which were on a Pacific Daylight Time basis to Pacific Standard time. The second program inspected the AQDHS-1 file and prepared matrices for each sampling day showing, by

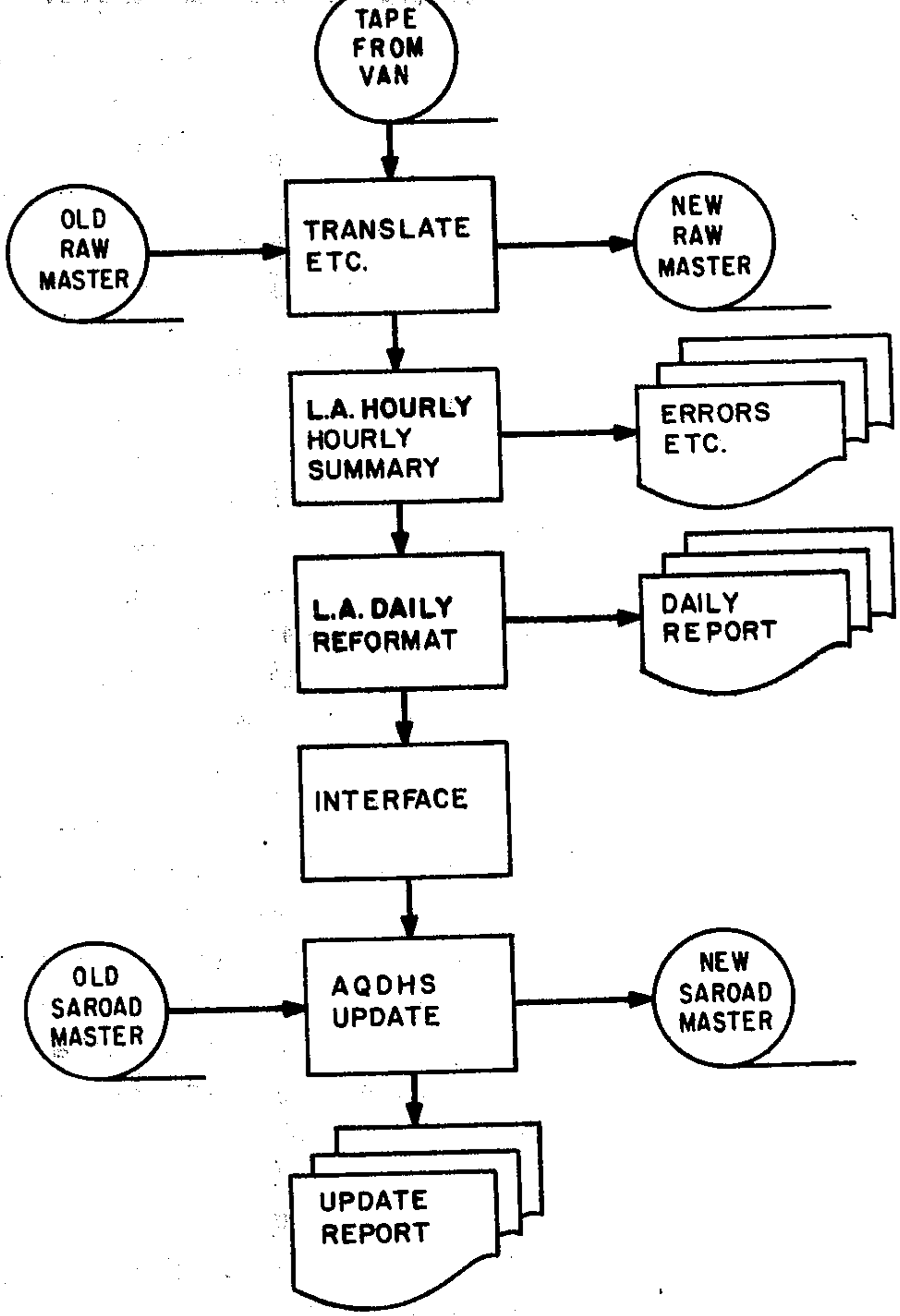


FIG. 1 FLOW CHART FOR UPDATING MASTER FILE

meteorologic observation and/or pollutant, the hours for which valid data exist and the hours valid data did not exist. The third program edited the raw data tapes by reading them against the matrices, passing the data during the hours for which valid data existed in the AQDHS-1 file, and purging the data during the hours the AQDHS-1 file was empty.

The data base and copies of the three computer programs mentioned above are now in the possession of the Federal Highway Administration Research Office in Washington, D. C.

Forty-four of the 230 original tapes generated by our research van did not pass into the AQDHS-1 file. Only unedited raw data for these 44 tapes are included in the data base. We are planning to investigate this problem with the intention of entering these rejected data into the file.

The traffic count data are from the years 1974-75. The Surveillance Loop traffic count file contains a myriad of traffic data, but only selected counts near our sampling sites were included in the FHWA data file.

The data on heavy duty vehicles (diesel and gasoline) were taken from Caltrans counts in 1974-75.

Raw Data

For each day the mobile laboratory was operated, one uniquely numbered raw data tape exists. The tapes were generated by the Hewlett-Packard mini-computer. Program ENG 136 updates the raw data by reformatting the Hewlett-Packard raw data tapes to IBM compatible format. These raw data tapes are fed from Program ENG 136 as numerical voltage figures, referred to here as the "decimal voltage equivalent" (DVE), along with the time and the "device" and "subdevice" codes. The raw data format is:

Error Flag +Device Code	Sub Device Code	Hour	Minute	Second	(DVE) Integer 1	Integer 2
					Decimal Voltage Equivalent (real)	

7 Fields of 2 Bytes = 14 Bytes

If the device code exceeds 64, the error flag is "on", and the device code is obtained by subtracting 64.

The last two fields are treated as two integer fields or one real data field depending on the device code and include the decimal voltage equivalent.

Two types of updates were done: (1) update incorrect header information on any of the first 4 header cards; (2) update hour values by ± 1 hour in all records for any one day to correct for daylight saving time.

Listings of the Device Codes and the Subdevice Codes

Table I equates the pollutant and meteorologic parameters to the corresponding device and subdevice codes.

TABLE I

Device Code	Sub-Device Code	Parameter and Parameter Code	Site Code X = 1 for Site #1 2 for Site #2, etc.
0	0	Calibration Potential	
1	1	CO 42101	X01
1	2	"	X02
1	3	"	X03
1	4	"	X04
1	5	"	X05
2	1	"	X06
2	2	"	X07
2	3	"	X08
2	4	"	X09
2	5	"	X10
3	1	"	X11
3	2	"	X12
3	3	"	X13
3	4	"	X14
3	5	"	X15
4	0	THC 43101	X01 - X09
5	0	CCO 42101	X01 - X09
6	0	CH4 43201	X01 - X09
7	0	NO 42601	X01 - X09
8	0	NO_2 42602	X01 - X09
9	0	NO_x 42603	X01 - X09
10	0	H2S 42402	X06
10	1	S02 42401	X06

Listings of the Device Codes and the Subdevice Codes

Table I equates the pollutant and meteorologic parameters to the corresponding device and subdevice codes.

TABLE I

Device Code	Sub-Device Code	Parameter and Parameter Code	Site Code X = 1 for Site #1, 2 for Site #2, etc.
0	0	Calibration Potential	
1	1	CO 42101	X01
1	2		X02
1	3		X03
1	4		X04
1	5		X05
2	1		X06
2	2		X07
2	3		X08
2	4		X09
2	5		X10
3	1		X11
3	2		X12
3	3		X13
3	4		X14
3	5		X15
4	0	THC 43101	X01 - X09
5	0	CCO 42101	X01 - X09
6	0	CH4 43201	X01 - X09
7	0	NO 42601	X01 - X09
8	0	NO_2 42602	X01 - X09
9	0	NO_x 42603	X01 - X09
10	0	H2S 42402	X06
10	1	S02 42401	X06

TABLE I (Continued)

Device Code	Sub-Device Code	Parameter and Parameter Code	Site Code X = 1 for Site #1 2 for Site #2 etc.
11	0	THTA 75400	X01
11	1	THTA (Std. Deviation)	X01
12	0	UBAR 75000	X01
13	0	PHI 75500	X01
13	1	PHI (Std. Deviation)	X01
14	0	THTA 75400	X02
14	1	THTA (Std. Deviation)	X02
15	0	UBAR 75000	X02
16	0	PHI 75500	X02
16	1	PHI (Std. Deviation)	X02
17	0	CUPA 75600	X01
18	0	CUPA 75600	X02
23	0	OZON 44201	X06
24	0	HUMD 75700	X01
25	0	SKY 75800	X01
28	0	TEMP 75900	X01
29	0	DELT 76000	X01
30	0	TEMP 75900	X02
31	0	DELT 76000	X02
32	0-7	Ignore	

Carbon monoxide by NDIR was sampled from 15 probes. As can be seen from Table I, the device codes for CO are 1, 2, or 3, and the subdevice codes are 1, 2, 3, 4, or 5. The combination of device codes and subdevice codes are determined by the probe number. For the 15 probes the device and subdevice codes are 1-1 through 1-5, 2-1 through 2-5, and 3-1 through 3-5. Thus Probe No. 1 is device code one, subdevice code one; Probe No. 5 is device code one, subdevice code five; Probe No. 6 is device code two, subdevice code one; Probe No. 7 is device code two, subdevice code two; Probe No. 12 is device code three, subdevice code two; etc.

In the LA Data Base, the probe numbers also determine the AQDHS "Site Code". The first digit of the three digit site code is the LA Data Base Site Number, the second and third digits represent the probe number. For example, site 1, probe 12 would have a site code of 112; site 3, probe 1 would be site code 301; site 5, probe 2 would be site code 502; etc. See Table I.

Total hydrocarbons, carbon monoxide by the gas chromatography method, methane, nitric oxide, nitrogen dioxide, and oxides of nitrogen are represented by device codes 4 through 9, respectively. Each hour's readings for each of these pollutants, however, yield nine distinct analyses. The nine analyses are on one sample per hour from each of probes 1 through 9 (see probe configuration figures)*. Probes 1 through 9 are read in numerical order once per hour. The AQDHS site codes for the latter pollutants use the same system as

*The sampling and analyzing done by the research van is fully discussed in "Variables Affecting Air Quality Instrument Operation", by Peter, Pinkerman, and Shirley, June 1977.

carbon monoxide. For a THC sample (AQDHS Parameter Code 43101) from Probe #9, Site #1, the site code is "109". For the same pollutant from Probe #2 at the same site, the site code is 102; for Probe #2, Site 3, the site code is 302; etc. See Table I for the site codes for the other pollutant and meteorological parameters.

Program LA Hourly

Program LA Hourly is designed to read the raw IBM compatible data from disk and reduce the decimal voltage equivalents from the raw data to units of recognized air pollution engineering terms by 1-hour averages.

Program ENV 018 can be used to obtain a printout of the raw data format shown on Page 5 which includes the device codes, subdevice codes, time, and decimal voltage equivalent (DVE). Using these codes and the formulas given below to reduce the DVE value, instantaneous parameter values can be obtained.

The decimal voltage equivalents (DVE) are converted to recognizible units by the following formulas:

First -- add 1 to the device code shown in Table I**

Carbon Monoxide (CO) -device codes 2, 3, and 4.
For device code #2 (# 1 before adding 1)
$CO\ (ppm) = .06 + 20.38\ (DVE) + 0.012\ (DVE)^2 - 0.05\ (DVE)^3$
For device code #3 (#2 before adding 1)
$CO\ (ppm) = .024 + 19.36\ (DVE) + 0.31\ (DVE)^2 -0.082\ (DVE)^3$

**The user must remember the LA HOURLY adds 1 to the device code before printing its output. Thus, device code 1, subdevice code 1 (CO probe #1) will appear as device code 2, subdevice code 1 on the LA HOURLY output.

```
        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=61,SIZE=0000K,
                           SOURCE,EBCDIC,LIST,DECK,NOLOAD,MAP,NOEDIT,NOID,XREF
                C          DATA SET TMENV018   AT LEVEL 006 AS OF 08/17/77
                C
                C     THIS PROGRAM LISTS THE RECORDS FROM RAW DATA TAPES CREATED
                C     BY THE LA RESEARCH VAN STUDY FOR A SELECTED HOUR
                C
  ISN 0002            DIMENSION IDATA(2)
  ISN 0003            INTEGER*2 IIN(7)
  ISN 0004            DATA BLANK,STAR/' ','*'/
  ISN 0005            READ (5,101) IHOUR
  ISN 0006        101 FORMAT (I2)
  ISN 0007         10 READ (8,100,END=20) IIN,DATA
  ISN 0008        100 FORMAT (7A2,T11,A4)
  ISN 0009            IDEV=IIN(1)+1
  ISN 0010            ISDEV=IIN(2)
  ISN 0011            IHR=IIN(3)
  ISN 0012            IF (IHOUR.EQ.IHR) GO TO 15
  ISN 0014            IF (IHR.GT.IHOUR) GO TO 20
  ISN 0016            IF (IDEV.GE.42 .AND. IDEV.LE.45) GO TO 15
  ISN 0018            GO TO 10
  ISN 0019         15 MIN=IIN(4)
  ISN 0020            ISEC=IIN(5)
  ISN 0021            IDATA(1)=IIN(6)
  ISN 0022            IDATA(2)=IIN(7)
  ISN 0023            ERCOD=BLANK
  ISN 0024            IF(IDEV.LE.64) GO TO 50
  ISN 0026            ERCOD=STAR
  ISN 0027            IDEV=IDEV-64
  ISN 0028         50 IF (IDEV.LE.11) GO TO 40
  ISN 0030            IF (IDEV.LE.20) GO TO 30
  ISN 0032            IF (IDEV.LE.42) GO TO 40
  ISN 0034            IF (IDEV.GT.45) GO TO 40
  ISN 0036         30 WRITE (6,110) ERCOD,IDEV,ISDEV,IHR,MIN,ISEC,DATA
  ISN 0037        110 FORMAT (1X,A1,3I4,2(1H:,I2),E18.8)
  ISN 0038            GO TO 10
  ISN 0039         40 WRITE (6,120) ERCOD,IDEV,ISDEV,IHR,MIN,ISEC,IDATA(1),IDATA(2)
  ISN 0040        120 FORMAT (1X,A1,3I4,2(1H:,I2),2I8)
  ISN 0041            GO TO 10
  ISN 0042         20 WRITE (6,130)
  ISN 0043        130 FORMAT ('0    END OF SELECTED DATA')
  ISN 0044            STOP
  ISN 0045            END
```

For device code #4 (#3 before adding 1)

$$CO\ (ppm) = -.05 + 18.82\ (DVE) + 0.813\ (DVE)^2 - 0.158\ (DVE)^3$$

Total hydrocarbons - device code #5

$$THC\ (ppm) = (DVE)\ \frac{50.}{1016.}$$

Carbon monoxide by gas chromatography - device code #6

$$CCO\ (ppm) = (DVE)\ \frac{100.}{1016.}$$

Methane - device code #7

$$CH_4\ (ppm) = (DVE)\ \frac{50.}{1016.}$$

Nitric oxide - device code #8
and Nitrogen dioxide - device code #9
and Oxides of nitrogen - device code #10

$$\left.\begin{array}{l} NO\ ppm \\ NO_2\ ppm \\ NO_x\ ppm \end{array}\right\} = (DVE)\ \frac{2.}{203.}$$

Relative Humidity - device code #25

Relative Humidity (%) $=\left(\frac{DVE}{1016.}\right)(149.) + 16.$

Solar Radiation - device code #26

Solar Radiation $\left(\frac{\text{milliwatts}}{cm^2}\right) = (DVE)\ \frac{106.}{101.6}$

Temperature - device codes #29 and #31

Temperature (°C) $=\left(\frac{DVE}{1016.}\right)(80.) -30.$

Difference in Temperature -device codes #30 and #32

$\Delta T(°C) = \left(\frac{DVE}{1016.}\right)(6.) -3.$

Year and Julian Day - device code #42

Read directly

Location - device code #43

Read first digit as District 07, second digit as site (1-5)

Magnetic data tape number - device code #44

Read directly

*Traffic monitoring system - device code 33, sub device codes 0 to 7.

All read directly

First field is traffic count

Second field is speed

Hydrogen Sulfide - device code #11, subdevice code 0

H_2S (ppm) $= (DVE)\ \frac{0.25}{203.}$

*Expect to find few, if any, traffic entries on the tapes.

Sulfur dioxide - device code #11 subdevice code 1

SLINE = 80. for site 1; = 135. for site 2; = 330. for site 3;
= 140. for site 4; = 0 for site 5

$$SO_2 \text{ (ppm)} = -0.001 + 1.32 \text{ (DVE)}\left(\frac{0.04}{2.03}\right) + 0.00008 \text{ (SLINE)}$$

Bivane #1

Anemometer Azimuth - device codes #12 and #15

$$\text{THETA (radians)} = \text{(DVE)} \frac{\left(\frac{540.}{1016.}\right)(2\pi)}{(100.)(360)}$$

Bivane Speed - device codes #13 and #16

$$\overline{U} \text{ (meter/sec.)} = \text{(DVE)} \frac{(20.)\ (88.)}{(1016.)(60.)(3.28)(100.)}$$

Vertical Angle - device codes #14 and #17

$$\text{PHI (radians)} = \left\{\left[\text{(DVE)}\frac{\left(\frac{120.}{1016.}\right)}{100.}\right] -60.\right\} \frac{2\pi}{360.}$$

Cup anemometer - device codes #18 and #19

Formulas are the same as Bivane Speed

Ozone - device code #24

$$O_3 \text{ (ppm)} = \text{(DVE)} \frac{2.}{203.}$$

LA HOURLY RAW DATA

The data on the following pages(Table II) represent a list of the edited and unedited raw data tapes created by the LA Research Van project. The unedited data are a complete copy of all data created during the course of the project and are discussed in the "Raw Data" section.

The edited raw data are those data which were considered sufficient and valid for summarization in the AQDHS-1 master data files for the project. Forty-four days of raw data were not put into the AQDHS master file, thus the edited raw data tapes do not contain data for these days. These days are indicated in the "Edited Raw Data" column by the entry "no validity data". The AQDHS area and site codes for the Los Angeles Study sampling locations are shown in Table III.

These data can be extracted from the data base tapes in the following manner:

All unedited raw data are on standard label 1600 BPI tape reels as noted in the column headed "Vol Ser Raw Data". The standard label for all data files is of the form:

TM.ENV.LAHOURLY.RAWDATA.DAY<u>YYDDD</u>.T<u>NNN</u>

where <u>YY</u> is the year
<u>DDD</u> is the julian day
<u>NNN</u> is the original tape number for that day's data

These values can be obtained from the following listing under the heading "Day" and "Tape No.". If there is a discrepancy in the label for the file different from those values, it is noted under "Remarks".

All edited raw data are likewise named:

TM.ENV.LAHOURLY.RAWEDIT.DAYYYDDD.TNNN with the same day and tape numbers as the equivalent unedited raw data files (unless noted under "Remarks"). These are in AQDHS-1 format, and can be accessed by EPA programs for AQDHS-1. Please refer to EPA Publication APTD-1086 "Air Quality Data Handling System Users Manual".

The tape volume number for the edited raw data tapes is located under "Vol Ser Edited Raw Data".

The "Label" information refers to the label on the corresponding unedited and edited raw data tapes.

In some cases a file exists for edited raw data which do not exist. These files are empty and are so noted under "Remarks".

Days 74106, 74108, 74267 contained erroneous unedited raw data. These three days were corrected and put on another tape with data set names:

TM.ENV.LAHOURLY.RAWCORR.DAYYYDDD.TNNN

These data sets should be used in lieu of the RAWDATA data sets for these three days.

The hourly averaged data can also be accessed from the Caltrans AQDHS-1 file using programs developed by the EPA and/or Caltrans personnel.

TABLE II

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
74100	215	1	TM8001	1	TM8015	1	
101	216			2	"	2	
102	217			3	"	3	
105	218			4	"	4	
106	220			5*	"	5	Use Rawcorr (TM8011,2) for raw
108	221			6*	"	6	Use Rawcorr (TM8011,3) for raw
110	222			7	"	7	
112	223			8	"	8	
113	224			9	"	9	
115	226			10	"	10	
116	228			11	"	11	Edited Raw Data empty (hdr record only)
119	229			12	No validity data	--	No edited raw data
120	230			13	TM8015	12	
121	231			14	"	13	
122	232			15	"	14	
123	233			16	"	15	
126	234			17	"	16	
128	236			18	"	17	
129	237			19	"	18	
130	238			20	"	19	
133	239		TM8002	1	"	20	
134	240			2	"	21	
135	241			3	TM8016	1	
136	242			4	"	2	
137	243			5	"	3	

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
74140	244	1	TM8002	6	TM8016	4	
141	245			7	"	5	
142	246			8	"	6	
143	247			9	"	7	
144	248			10	"	8	
148	249			11	"	9	
149	250			12	"	10	
150	251			13	"	11	
151	252			14	"	12	
154	253			15	"	13	
156	254			16	"	14	
157	255		TM8003	1	"	15	Raw data mis-named day 74161 Edited misnamed T257
158	256			2	"	16	
161	257			3	"	17	
162	258			4	TM8017	1	
163	259			5	"	2	
164	260	2		6	"	3	
165	261			7	No validity data	--	No edited raw data
168	262			8	" " " " "	--	" "
169	263			9	" " " " "	--	" "
170	264			10	TM8017	4	
171	265			11	"	5	
172	266			12	"	6	
175	267			13	No validity data	--	No edited raw data. Use Raw-corr TM8011,4 for raw
176	268			14	" " " " "	--	No edited raw data

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
74177	270	2	TM8003	15	TM8017	7	
178	271			16	"	8	
179	272			17	"	9	
182	273			18	"	10	
184	275			19	"	11	
189	276			20	"	12	
190	277			21	"	13	
191	278		TM8004	1	"	14	
192	279			2	"	15	
193	280			3	"	16	
196	281			4	"	17	
197	283			5	No validity data	--	No edited data
198	284			6	TM8017	18	
199	285			7	"	19	
228	300	3		8	No validity data	--	No edited data
231	301			9	TM8017	20	
232	303			10	"	21	
233	304			11	"	22	
234	305			12	TM8018	1	
235	306			13	"	2	
238	307			14	"	3	
239	308			15	"	4	
240	309			16	"	5	
241	310			17	"	6	
242	311			18	"	7	
246	312		TM8005	1	"	8	Only header rec on edited data
247	313			2	"	9	
248	314			3	"	10	
249	315			4	"	11	

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
74253	316	3	TM8005	5	TM8018	12	
254	317			6	"	13	
255	318			7	"	14	
256	319			8	"	15	
259	320			9	TM8019	1	
260	321			10	"	2	
262	323			11	"	3	
263	324			12	No validity data	--	No edited data
266	325			13	TM8019	4	
267	326		TM8006	1	"	5	
268	328			2	"	6	
269	329			3	"	7	
270	330			4	No validity data	--	No edited data
273	331			5	TM8019	8	
274	332			6	No validity data	--	No edited data
275	333			7	" " " "	--	" " " "
276	334			8	" " " "	--	" " " "
277	335			9	" " " "	--	" " " "
280	336			10	" " " "	--	" " " "
288	337			11	TM8019	9	
289	338			12	"	10	
290	339			13	"	11	
291	340			14	No validity data	--	No edited data
294	341			15	TM8019	12	
295	342			16	"	13	
296	343			17	No validity data	--	No edited data

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
74297	344	3	TM8007	1	TM8019	14	
298	345			2	No validity data	--	No edited data
301	346			3	" " " "	--	No edited data
302	348			4	TM8019	15	
303	349			5	"	16	
304	350			6	No validity data	--	No edited data
305	351			7	" " " "	--	No edited data
308	352			8	" " " "	--	Ignore these data sets (see raw 11)
310	353			9	" " " "	--	No edited data
311	354			10	TM8020	1	
308*	352*			11	No validity data	--	No edited data
312	356			12	TM8021	1	
316	357			13	"	2	Edited data set is empty
317	358			14	"	3	
318	359			15	"	4	
319	360			16	"	5	
322	361			17	"	6	
323	362		TM8008	1	"	7	
324	363			2	"	8	Raw data file has T364 in name
325	364			3	"	9	
326	365			4	"	10	
329	366			5	No validity data	--	No edited data
330	367			6	" " " "	--	" " " "
331	368			7	" " " "	--	" " " "

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
74336	369	3	TM8008	8	TM8021	11	
337	370			9	"	12	
340	371			10	No validity data	--	No edited data
343	372			11	TM8021	13	
344	373			12	"	14	
345	374			13	"	15	
346	375			14	"	16	
347	376			15	"	17	
350	377		TM8009	1	TM8022	1	
351	378			2	"	2	
352	379			3	"	3	
353*	380			4	"	4	Raw data has T354 in name
354	381			5	"	5	
357	382			6	"	6	
358	383			7	"	7	
75015	384			8	"	8	
016	385			9	"	9	
017	386			10	"	10	
020	387			11	No validity data	--	No edited data
021	388			12	TM8022	11	
022	389			13	"	12	
023	390			14	"	13	
024	391			15	"	14	
027	392			16	"	15	
028	393			17	"	16	
029	394			18	"	17	
030	395		TM8010	1	"	18	
031	396		"	2	"	19	

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
75034	397	3	TM8010	3	047641	1	
035	398			4	"	2	
036	399			5	"	3	
037	400			6	"	4	
038	401			7	"	5	
041	402			8	"	6	
042	403			9	"	7	
044	404			10	"	8	
045	405			11	"	9	
049	406			12	"	10	
050	407			13	"	11	
051	408			14	"	12	
052	409		036163	1	"	13	
055	410			2	No validity data	--	No edited data
056	411			3	047641	14	
057	412			4	"	15	
058	413			5	"	16	
059	414			6	048216	1	
062	415			7	"	2	
063	416			8	"	3	
064	417			9	"	4	
065	418			10	"	5	
066	419			11	"	6	
069	420			12	"	7	
070	421			13	"	8	
071	422			14	"	9	
072	423		TM8012	1	"	10	
073	424		"	2	"	11	

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
75076	425	3	TM8012	3	048216	12	
077	426			4	"	13	
078	427			5	"	14	
079	428			6	No validity data	--	No edited data
080	429			7	048830	1	
083	430			8	"	2	
084	431			9	"	3	
085	432			10	"	4	
086	433			11	"	5	
087	434			12	"	6	
090	435			13	"	7	
091	436			14	"	8	
092	437			15	"	9	
093	438		TM8013	1	"	10	
094	439			2	"	11	
097	440			3	"	12	
100	441			4	"	13	
101	442			5	No validity data	--	No edited data
104	443			6	048830	14	
105	444			7	"	15	
106	445			8	"	16	
107	446			9	No validity data	--	No edited data
108	447			10	048830	17	
111	449			11	"	18	
112	451			12	009577	1	
113	452			13	"	2	Empty data set (no validity data)
114	453			14	"	3	
115	454			15	"	4	
116	456			16	No validity data	--	No edited data

TABLE II (Continued)

Day	Input Tape No.	Site	Vol Ser Raw Data	Label	Vol Ser Edited Raw Data	Label	Remarks
75151	501	5	TM8013	17	009577	5	
153	502		"	18	"	6	
156	503		TM8014	1	"	7	
157	504			2	"	8	
160	505			3	No validity data	--	No edited data
161	506			4	" " "	--	" " "
162	507			5	" " "	--	" " "
163	508			6	" " "	--	" " "
164	509			7	009577	9	
167	510			8	"	10	
168	511			9	"	11	
169	512			10	"	12	
170	513			11	No validity data	--	No edited data
171	514			12	009577	13	
174	515			13	No validity data	--	No edited data
175	516			14	009577	14	
176	517			15	No validity data	--	No edited data
178	519		TM8011	1	" " "	--	" " "
74106	220	1	TM8011	2			Corrected raw data
108	221	1	"	3			" "
175	266	2	"	4			" "

Table III

AQDHS Area and Site Codes for LA
Hourly Data

	Area Code	Site Code
*Site 1 - Santa Monica Freeway at 4th Avenue Pedestrian Overcrossing	4180	1XX
*Site 2 - Same location	4180	2XX
Site 3 - San Diego Freeway at 134th Street	3120	3XX
Site 5 - Santa Ana Freeway near El Toro	2390	5XX

*Sites 1 and 2 differ in probe configurations only

In the AQDHS-1 file for the LA study no information exists for "Barometric Pressure". The file will either be empty or show "0" and should be ignored.

The temperature difference (ΔT) should also not be considered by a potential user. The AQDHS-1 file will not handle minus signs "-", and negative values of ΔT occur quite frequently. The raw data, however, are correct for ΔT.

The mathematics used to calculate the standard deviation of the anemometer azimuth (THETA) are erroneous and information in the AQDHS-1 file and the raw data should not be used.

User's Instructions for Surveillance Loop Traffic Count Data Tapes

Tape attributes:
1600 BPI
9 track
binary
record length 96
blocksize 7200
file name - TM.ENV.LAHOURLY.TRAFFIC.COUNT.FILEX

The start day, stop day, number of days data, and label position are on the attached listing, Table IV. The file name parameter "FILEX" is also on this listing where X is the input file number. A format of the records on each file is attached in the format description.

"Lanes" is the number of directional lanes of traffic at the sampling point, and "Active Lanes" is the number of lanes actually being sampled at that point. "Vol" represents the traffic volumes for active lanes only. This information will need normalization for total lanes. "Occupancy" is a parameter from which traffic speed was calculated. The formula used to calculate speed from the "Occupancy" value was:

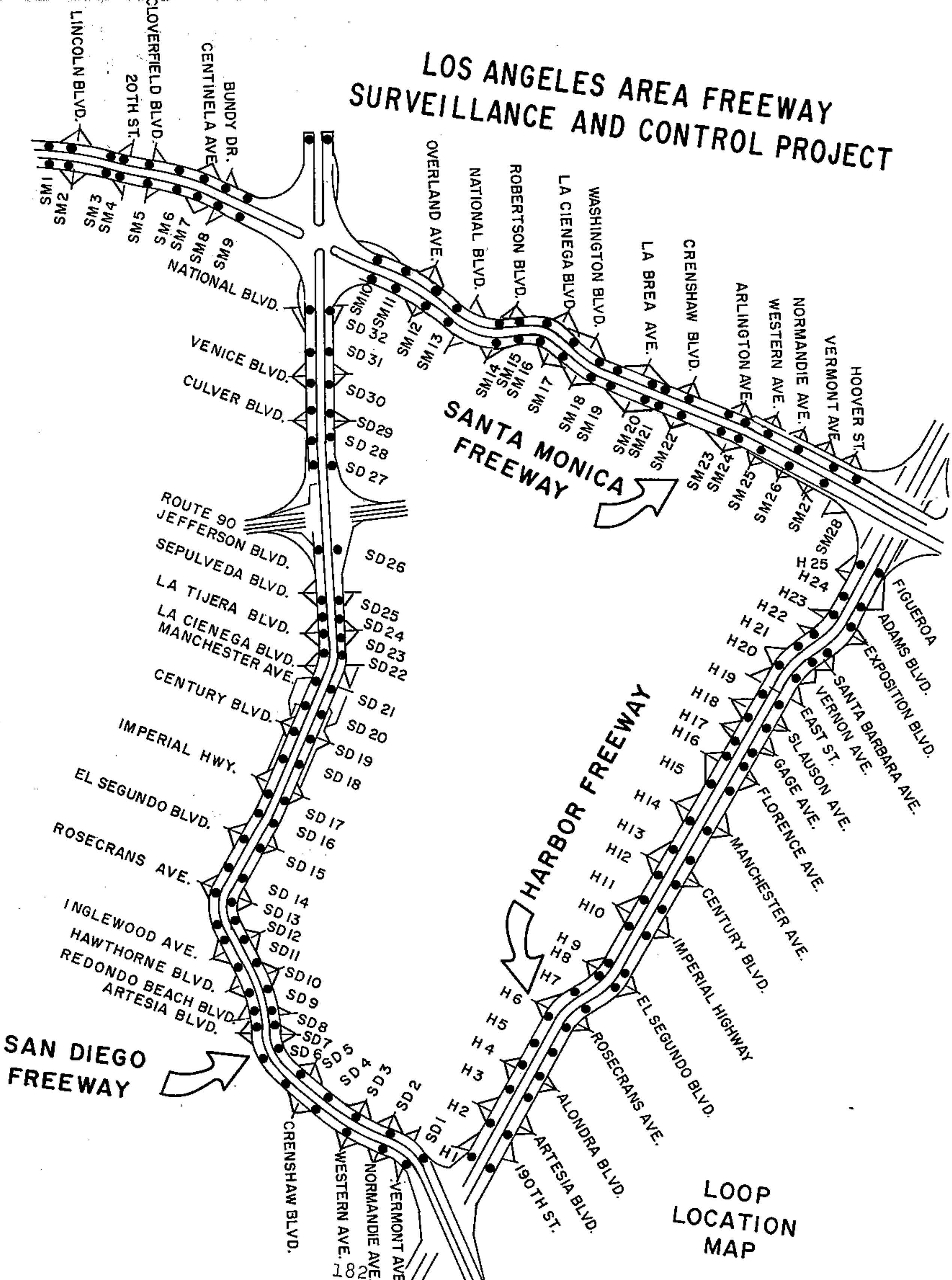
Speed = VPH/[(no. of lanes) (occupancy) (K)]

where K = 5280/(average vehicle length)

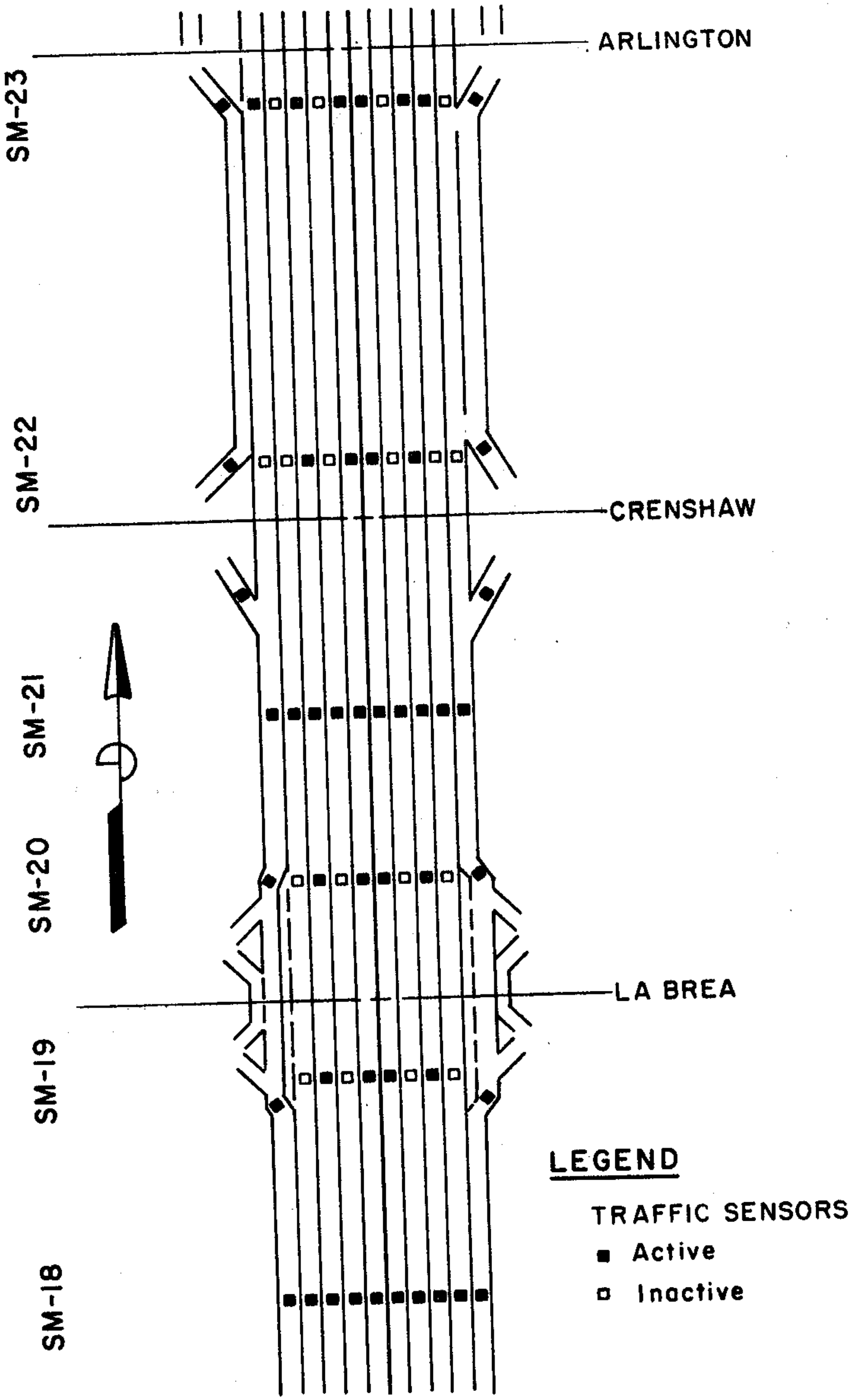
and VPH = volume per hour.

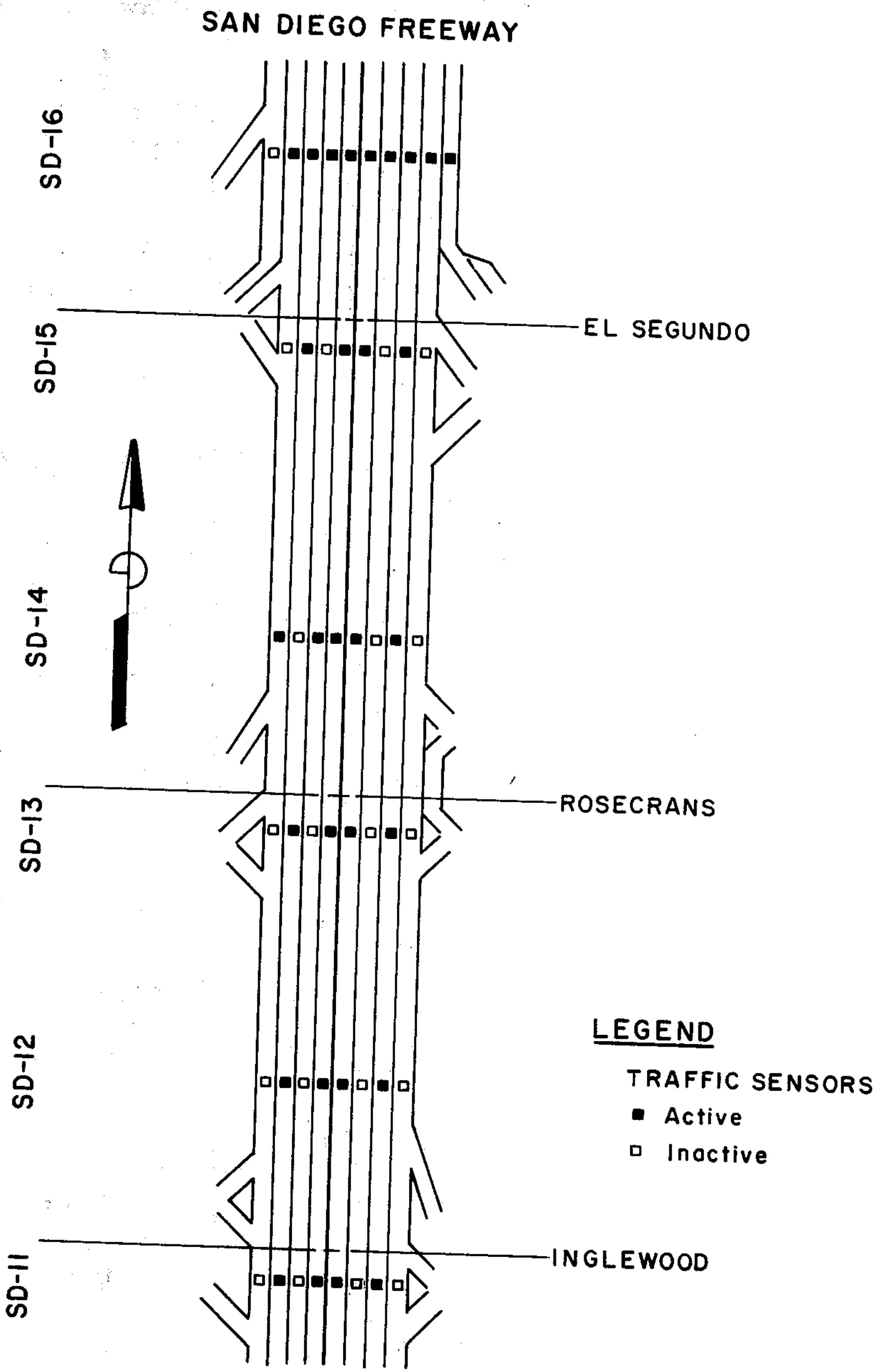
For the Transportation Laboratory's purposes, K was assumed to be 272. For low occupancy values the speeds do not reflect actual conditions because of significance problems. Speeds on the order of 400 mph can be calculated, thus care must be taken when using the "occupancy" value to evaluate the traffic speed.

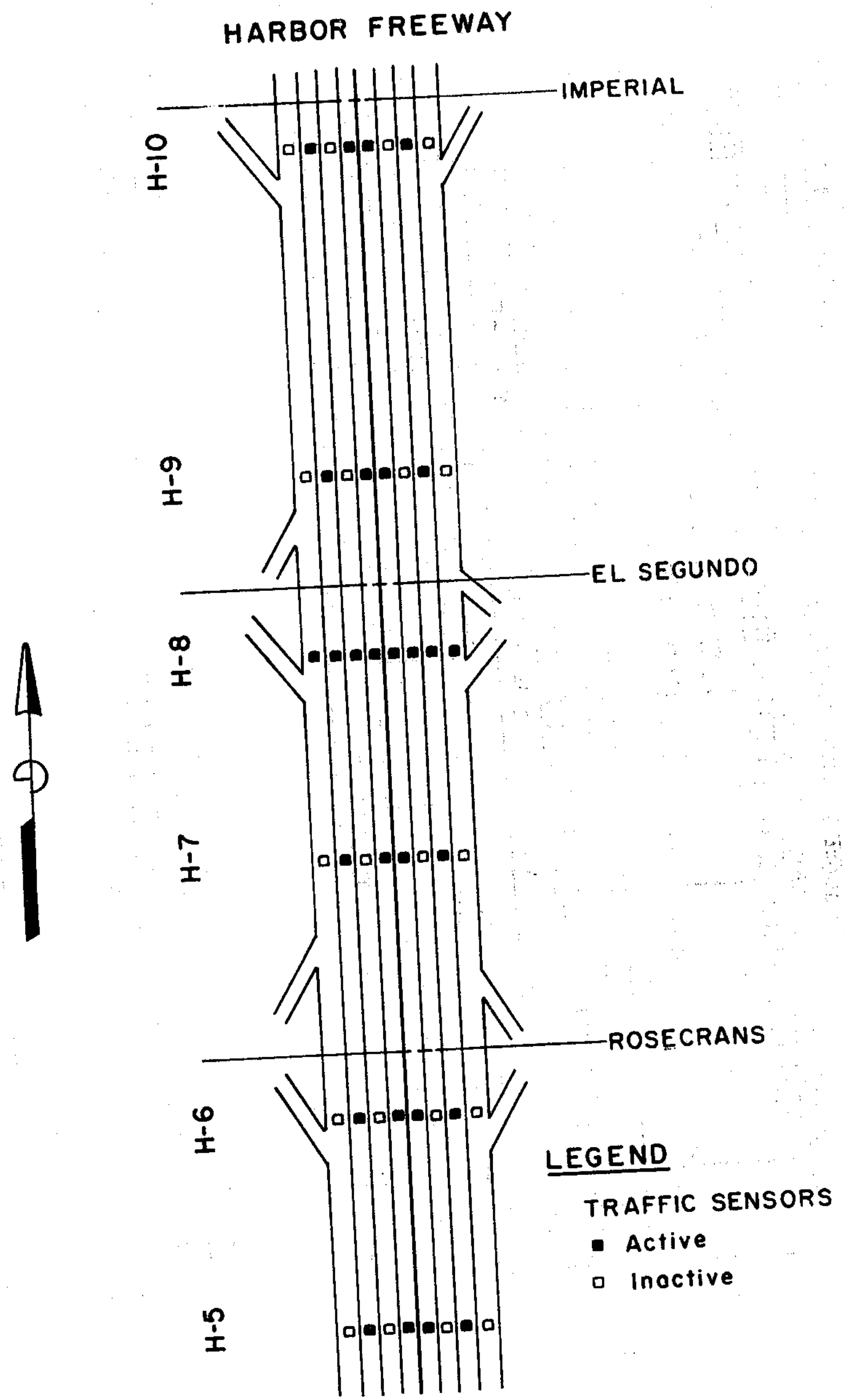
The foregoing user's instructions are for the traffic tapes from the "Surveillance Loop" and are useful for Sites Nos. 1, 2, and 3. The attached "Loop Location Map" and large scale freeway schematics will serve to locate the traffic monitoring stations which generated the traffic tape data.


LOS ANGELES AREA FREEWAY
SURVEILLANCE AND CONTROL PROJECT
SANTA MONICA FREEWAY
SAN DIEGO FREEWAY
HARBOR FREEWAY
LOOP LOCATION MAP
LINCOLN BLVD.
20TH ST.
CLOVERFIELD BLVD.
CENTINELA AVE.
BUNDY DR.
SM1 SM2 SM3 SM4 SM5 SM6 SM7 SM8 SM9
NATIONAL BLVD.
OVERLAND AVE.
NATIONAL BLVD.
ROBERTSON BLVD.
LA CIENEGA BLVD.
WASHINGTON BLVD.
LA BREA AVE.
CRENSHAW BLVD.
ARLINGTON AVE.
WESTERN AVE.
NORMANDIE AVE.
VERMONT AVE.
HOOVER ST.
SM10 SM11 SM12 SM13 SM14 SM15 SM16 SM17 SM18 SM19 SM20 SM21 SM22 SM23 SM24 SM25 SM26 SM27 SM28
VENICE BLVD.
CULVER BLVD.
ROUTE 90
JEFFERSON BLVD.
SEPULVEDA BLVD.
LA TIJERA BLVD.
LA CIENEGA BLVD.
MANCHESTER AVE.
CENTURY BLVD.
IMPERIAL HWY.
EL SEGUNDO BLVD.
ROSECRANS AVE.
INGLEWOOD AVE.
HAWTHORNE BLVD.
REDONDO BEACH BLVD.
ARTESIA BLVD.
CRENSHAW BLVD.
WESTERN AVE.
NORMANDIE AVE.
VERMONT AVE.
SD 32 SD 31 SD30 SD29 SD 28 SD 27 SD26 SD25 SD 24 SD 23 SD22 SD 21 SD 20 SD 19 SD 18 SD 17 SD 16 SD 15 SD 14 SD 13 SD12 SD11 SD10 SD 9 SD8 SD7 SD 6 SD 5 SD 4 SD 3 SD 2 SD 1
FIGUEROA
ADAMS BLVD.
EXPOSITION BLVD.
SANTA BARBARA AVE.
VERNON AVE.
EAST ST.
SLAUSON AVE.
GAGE AVE.
FLORENCE AVE.
MANCHESTER AVE.
CENTURY BLVD.
IMPERIAL HIGHWAY
EL SEGUNDO BLVD.
ROSECRANS AVE.
ALONDRA BLVD.
ARTESIA BLVD.
190TH ST.
H 25 H24 H23 H22 H 21 H20 H19 H18 H17 H16 H15 H14 H13 H12 H11 H10 H 9 H8 H7 H6 H5 H4 H3 H2 H1

SANTA MONICA FREEWAY




SAN DIEGO FREEWAY
SD-16
SD-15
SD-14
SD-13
SD-12
SD-11
EL SEGUNDO
ROSECRANS
INGLEWOOD
LEGEND
TRAFFIC SENSORS
Active
Inactive


HARBOR FREEWAY
IMPERIAL
H-10
H-9
EL SEGUNDO
H-8
H-7
ROSECRANS
H-6
H-5
LEGEND
TRAFFIC SENSORS
Active
Inactive

FORMAT DESCRIPTION

ENVØØ4
PROGRAM ORIGINATING FORMAT (NUMBER, FILE CODE, AND NAME)

DATE	ORIGINATOR	REVIEWER
3-15-77	JWF	

FILE NAME TM.ENV.LAHOURLY.TRAFFIC.COUNT.FILE* FORMAT TITLE

Columns 1–50

Year	Month	Day	Hour	Minute	Second	Site SM 23 E				Site SM 23 W				
						Lanes	Active Lanes	Vol.	Occ.	Lanes	Active Lanes	Vol.	Occ.	Lanes

Columns 51–100

Site SD 14 N				Site SD 14 S				Site H5 N				Site H5 S				
Lanes (cont.)	Active Lanes	Vol.	Occ.	Lanes	Active Lanes	Vol.	Occ.	Lanes	Active Lanes	Vol.	Occ.	Lanes	Active Lanes	Vol.	Occ.	EOR

Columns 101–150

Columns 151–200

MODE:
BINARY-(B)
PACKED-P

LABELS:
STANDARD ☒
NON-STANDARD ☐
NO LABELS ☐

RECORD FORMAT:
FIXED-F ☒
VARIABLE-V ☐
UNDEFINED-U ☐

RECORD LENGTH 96
RECORDS PER BLOCK 75
BLOCK SIZE 7200

INPUT ☐
OUTPUT ☒

PAGE 1 OF 1

TABLE IV

Tape No.	Start Day	Stop Day	No. Days Data	Remarks
007789	4-09-74	5-06-74	--	Tape contains too many errors, ignore
017736	5-08-74	6-05-74	29	032965 1,SL FILE2
006510	6-05-74	6-25-74	21	2,SL FILE3
010460	6-27-74	7-24-74	26	3,SL FILE3 (should be 4)
020419	8-06-74	8-31-74	26	4,SL FILE3 (should be 5)
009930	9-01-74	9-08-74	26	5,SL FILE6
008116	9-11-74	10-07-74	28	6,SL FILE7
011039	10-08-74	10-31-74	26	7,SL FILE8
001680	11-01-74	11-26.74	23	8,SL FILE9
016418	11-27-74	12-11-74	11	9,SL FILE10
007398	12-12-74	1-07-75	24	10,SL FILE11
006217	1-08-75	1-25-75	16	11,SL FILE12
002265	2-10-75	2-28-75	19	12,SL FILE13
012162	3-03-75	3-31-75	25	13,SL FILE14

Site 5 Traffic Data

Traffic information that we had planned to use with the pollutant and meteorologic data for Site 5 (Route 5 near El Toro) were lost due to the expiration of a computer file. We have, however, collected bits and pieces of available data in an attempt to reconstruct a traffic inventory for Site 5.

1. The average total traffic for the monitoring period was on the order of 88,000 vehicles per day.

2. Trucks, as a percent of total vehicles, totaled 6.1% or 5400 trucks per day.

3. Of the total number of trucks, 45% were 2-axle, 10% were 3-axle, 6% were 4-axle, and 39% were 5-axle or greater. It should be assumed that the multi-axled trucks, or 55% of the total, were diesel-powered.

4. The following percentages of traffic were extrapolated from December 1975, and July 1976 traffic count data near the monitoring site. The hours are on the 0000 to 2400 "military clock" basis.

0000 to 0100 = 1.2%; 0100 to 0200 = 0.7%; 0200 to 0300 = 0.5%;
0300 to 0400 = 0.4%; 0400 to 0500 = 0.6%; 0500 to 0600 = 1.7%;
0600 to 0700 = 5.2%; 0700 to 0800 = 8.7%; 0800 to 0900 = 6.9%;
0900 to 1000 = 5.2%; 1000 to 1100 = 5.0%; 1100 to 1200 = 5.0%;
1200 to 1300 = 4.8%; 1300 to 1400 = 4.8%; 1400 to 1500 = 5.4%;
1500 to 1600 = 7.1%; 1600 to 1700 = 7.7%; 1700 to 1800 = 8.2%;
1800 to 1900 = 6.3%; 1900 to 2000 = 4.4%; 2000 to 2100 = 3.1%;
2100 to 2200 = 2.8%; 2200 to 2300 = 2.5%; 2300 to 2400 = 1.8%.

When emissions are being considered in connection with Site 5, it is recommended that necessary traffic data be developed from the preceding information.